Economic Impacts of Climate Change Mitigation / Adaptation in the East Midlands – Stage 1 Report

A report prepared for *emda*

Atkins

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EAST MIDLANDS DEVELOPMENT AGENCY

Economic Impacts of Climate Change Mitigation / Adaptation in the East Midlands

Stage 1 Report

February 2007

Notice

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This document should be referenced as:

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GLOSSARY OF TERMS

Term	*Meaning / Definition*
BAP	Biodiversity Action Plan
BRE	Buildings Research Establishment
BWEA	British Wind Energy Association
CCL	Climate Change Levy
CER	Certified Emission Reduction
CHP	Combined Heat and Power
CO_2	Carbon Dioxide
COP	Conference of Parties (to the Kyoto Protocol)
DCLG	Department for Communities and Local Government
Defra	Department for Environment, Food and Rural Affairs
DETR	Department for Environment, Transport and the Regions
DfT	Department for Transport
DoH	Department of Health
DTI	Department of Trade and Industry
ECCP	European Climate Change Programme
EEC	Energy Efficiency Commitments
EMCC	East Midlands Cooperative Council
Emda	East Midlands Development Agency
EMRA	East Midlands Regional Assembly
ERU	Emission Reduction Unit
EU ETS	European Union Emission Trading Scheme
GHG	Greenhouse Gas
GJ	Giga joule
GOEM	Government Office East Midlands
HECA	Home Energy Conservation Act
IRS	Integrated Regional Study
IPCC	Intergovernmental Panel on Climate Change
KWh	Kilo watt hour
MKSM	Milton Keynes South Midlands
Ml	Mega litre
MW	Mega Watt
NEMA	Nottingham East Midlands Airport
NET	Nottingham Express Transit
ODPM	Office of the Deputy Prime Minister
OECD	Organisation for Economic Co-operation and Development
ONS	Office for National Statistics
PDNP	Peak District National Park

ppmv	Parts per million (volume)
RCEP	Royal Commission on Environmental Pollution
RHB	Regional Housing Board
RO	Renewables Obligation
ROCs	Renewable Obligation Certificates
RSS	Regional Spatial Strategy
RTS	Regional Transport Strategy
SEEM	Social Enterprise East Midlands
SEV	Sherwood Energy Village
SFRA	Strategic Flood Risk Appraisal
RTFO	Renewable Transport Fuel Obligation
UKCCP	United Kingdom Climate Change Programme
UKCIP	United Kingdom Climate Impact Programme
UNFCCC	United Nations Framework Convention on Climate Change
VA	Voluntary Agreement
VED	Vehicle Excise Duty

1 Introduction

1.1 Background

There is little doubt that climate change is a reality and that it will pervade all areas of life. While there are impacts that are no longer avoidable, there is still time to develop adaptation techniques to cope with a changing climate, and mitigation strategies to limit further damage in the 21st century.

The Earth's climate is dynamic; the planet alternates between periods of glacial (cold) and interglacial (warm) conditions as part of its natural cycle (IPCC, 2001). While this is often altered by such events as large volcanic eruptions, the cycle is consistent. For the past 10,000 years the Earth has been in an interglacial period, which has provided a comfortable 15°C average surface temperature for mankind. However, there is substantial evidence that the impact of human activities has caused, and will continue to cause, a steady but significant increase in this average surface temperature.

The Earth is kept warm by certain gases in its atmosphere; gases such as water vapour, carbon dioxide and methane absorb outgoing radiation and re-emit it back to the Earth's surface. This has been described as the 'greenhouse effect', without which the Earth's surface would be approximately 33°C colder. Since the industrial revolution, mankind has gradually and consistently been adding to the greenhouse gases already in the atmosphere. Through burning of fossil fuels, changes in land use and a voracious appetite for energy, the volume of greenhouse gases has increased from 270 ppmv in pre-industrial times to 379 ppmv in 2005 (IPCC, 2007). This far exceeds the natural range of the past 650,000 years (180 to 300 ppmv) as determined by ice cores (IPCC, 2007). This has caused an intensification of the greenhouse effect and a gradual warming of the Earth.

The challenge of global climate change requires profound changes in the way that natural resources are used. This is a challenge across all sectors and activities including business, construction, households and transport. Moving towards a resource efficient low carbon economy represents a huge cultural challenge for consumers and producers. At the same time it offers a significant economic opportunity in terms of productivity savings, new market opportunities and increased economic resilience.

The recent review of the economic effects of climate change by Nicholas Stern highlights the threat of climate change to the world economy. According to the report, a 2 or 3°C rise in global average temperature could reduce global output by 3%, this figure increases to 10% for a 5°C rise (Stern, 2006). In the worst-case scenario, global consumption would fall by 20% (ibid). The review states that 'The evidence shows that ignoring climate change will eventually damage economic growth. Our actions over the coming few decades could create risks of major disruption to economic and social activity, later in this century and in the next, on a scale similar to those associated with the great wars and the economic depression of the first half of the 20th century' (ibid).

Whilst it is vitally important for the East Midlands region to develop a response to the challenge of climate change, robust climate change scenarios which model the likely aspects and impacts of climate change tend to be concentrated at the national and international level, with relatively little climate data (and corresponding analysis and accessible evidence) available to inform regional mitigation and adaptation activities. This study will help to build intelligence regarding the impacts of climate change on the region and create insights as to

how the likely economic, environmental and social impacts can be mitigated, adaptive actions undertaken and market/productivity opportunities capitalised on by regional businesses.

1.2 Methodology

This report comprises the results from Stage 1 of the East Midlands Development Agency (emda) project 'Economic Impacts and Opportunities of Climate Change Mitigation/Adaptation in the East Midlands (TRN61)'. This initial report provides a scoping of the climate change and economic issues present in the East Midlands and selects case studies for detailed evaluation in Stage 2.

Information on the impacts of climate variability and climate change in the 2000 Entec scoping study, the 2004 update and more recent literature has been critically examined, and current responses to climatic conditions (i.e. the adaptation baseline) has been considered. This has been combined with identifying up to date, reliable, regionally-specific and sufficiently detailed descriptions of the current vulnerability of the region, in the context of the social, economic and environmental dimensions of development plans / policy priorities. Similarly, proposed or existing policies and measures that will affect regional energy use and carbon emissions have been critically reviewed. These strategies have been examined in the context of threats and opportunities to the identified social, economic and environmental dimensions of development plans and policy priorities for the Region.

This report also details the output from the mapping exercise, represented as a "cross-impact matrix" in which the consequences of specific linkages between policy priorities are characterised sufficiently to allow the identification of priorities for the detailed case studies.

From the mapping exercise, 11 case studies are outlined for the next stage of the project. These cover a range of topics within the Regional Economic Strategy (RES), as well as covering both mitigation of, and adaptation to, climate change.

1.3 Report Structure

This report covers the results of the mapping, evaluation and prioritisation exercises in Stage 1 of the project, and includes recommendations for the high-resolution case studies, including system boundaries (e.g. the temporal, spatial and physical boundaries of the high resolution studies).

The report is structured in the following way:

- Section 2: Policy summary – a review of the economic, environmental and social policies currently in place for the East Midlands.
- Section 3: Climate change – an introduction to the climate of the East Midlands and the current consensus on the predicted changes for the Region in the 21st century.
- Section 4: Mitigation review – a discussion of mitigation policy and how it will impact the following sectors within the Region:
    - Water Resources
    - Flood Management
    - Biodiversity and Conservation
    - Agriculture, Horticulture and Forestry
    - Energy
    - Transport

  - Manufacturing, Industry and Services
  - Built Environment and Planning
  - Leisure and Tourism
  - Public Health
- Section 5: Adaptation review – a discussion of potential impacts or climate change in the Region and the adaptation currently in place. This section covers the same sectors as the mitigation review.
- Section 6: Mapping and Prioritisation – the results from the mapping exercise between the RES and key climate change mitigation policy and impact adaptation.
- Section 7: Case Studies – an introduction and outline of the case studies put forward for further analysis.
- Section 8: Conclusions – summarises the report and the first stage of the project.
- Section 9: References – a complete list of all cited references in the report
- Appendices:
  - Appendix A – a summary of all climate change mitigation policies that are applicable to the East Midlands – on international, national, regional and local scales.
  - Appendix B – the larger tables from the mapping exercise.

2 Regional Policy Review

2.1 Purpose of Policy review

This section reviews current regional strategies and policies and identifies the specific objectives and associated actions within these strategies. This informs the understanding of how climate change risks and opportunities relate to regional policy priorities and how these risks and opportunities may be prioritised for more detailed analysis (see Section 6).

This review entailed the following:

- Collation of relevant regional strategy/policy documentation.
- Summarising of policy areas, objectives and actions from this documentation.
- Cross-referencing policy areas objectives and actions between strategies and specifically in relation to the Regional Economic Strategy (RES).

2.2 Collation of relevant regional strategy/policy documentation

The various sectoral and cross-sectoral regional strategies were collated from the Emda, EMRA and Government of the East Midlands (GOEM) websites as well as personal contacts within Emda and EMRA. The strategy documents reviewed are listed in Table 2.1 and comprise the integrated Regional Strategy. These represent the principal strategies for the Region; a number of other documents, e.g. Urban and Rural Action Plans, have objectives and actions that are effectively included within these principal strategies.

Table 2.1 List of Regional Strategy documents reviewed

Name of Strategy Document	**Organisation; Date of publication**
Regional Economic Strategy & supporting documentation (inc. evidence base)	Emda; 2006
Draft Regional Plan, incorporating: Regional Spatial Strategy (inc. Milton Keynes & South Midlands Sub-Regional Strategy) & Regional Transport Strategy	GOEM; 2006 EMRA; 2005 EMRA; 2005
Regional Waste Strategy	EMRA; 2006
Regional Freight Strategy	EMRA; 2005
Tourism Strategy for the East Midlands	Emda, 2003
Regional Housing Strategy	RHB; 2004
Investment for Health	EMRA, 2002
Regional Cultural Strategy	EMCC; 2006
Change 4 Sport	SEEM; 2004
Regional Environmental Strategy	EMRA; 2002
Regional Energy Strategy, including Framework for Action	EMRA, 2002 EMRA, 2005
Regional Biodiversity Strategy	EMRA/EMBF
Space4trees	Forestry Commission; 2005

2.3 RES Priority Actions and Key Priority Actions

The RES is split into three broad themes; Raising Productivity, Ensuring Sustainability and Achieving Equality. Within these themes, policies are arranged under ten Strategic Priorities. Each policy, or priority, is described qualitatively in terms of action required. The aims and strategic priorities of the RES, as well as the priority action descriptions can be found in Appendix B. There are eight priority actions in the RES which Emda have identified as key; these are highlighted in red in Appendix B and presented in Table 2.2 below.

Table 2.2 Key Priority Actions within the RES

Aim	Strategic Priority	Priority	Key Priority Actions	Description of Priority Action
Raising Productivity	Employment, learning and skills	Developing the skill level of the current and future workforce	Develop adult workforce skills	Increase the proportion of the adult workforce studying for and gaining new qualifications by developing clear learning pathways for people in work
	Enterprise and business support	Building and enterprise culture	Harness a culture of enterprise	Create a continuous path of enterprise education and awareness available to all in the region, linked to the provision of start-up assistance for those who wish to access it
			Targeted provision to improve business creation	Create a coordinated long-term campaign to develop enterprise skills, raise the profile of enterprise and help people identify opportunities; focusing on people aged 35-55, particularly women.
	Innovation	Translating scientific excellence into business success	Commercialising Scientific Excellence through Facilitated Business Collaboration	Introduce more effective initiatives to facilitate greater collaboration between businesses and the regional research community, including the universities
		Growing the regions key sectors	Growing the Region's Key Sectors	Ensure that the priority sectors (transport equipment, construction, food and drink and healthcare) are considered in the implementation of other actions in the RES to support growth, address skills needs and focus on efficiency
Ensuring Sustainability	Transport and Logistics	Infrastructure accessibility and connectivity	Improve Transport Connectivity and Accessibility	Improve inter and intra-regional connectivity by strengthening links between the region's main urban centres, improving reliability on key routes for passengers and freight, and address poor connectivity or capacity to key centres in other regions, including London, Leeds, Birmingham, and Manchester; improve international accessibility by improving surface access to NEMA and other airports serving the region; implement demand management measures, and improve access to recreation, sport, and cultural facilities

Aim	Strategic Priority	Priority	Key Priority Actions	Description of Priority Action
	Energy and resources	Ensuring an infrastructure for a low carbon economy	Energy and Waste Capacity	Promote the development of a more secure, diverse and sustainable energy and waste infrastructure and innovative approaches to providing energy and waste services by: promoting and investing in renewable and low carbon energy generation; promoting and investing in diverse and localised energy supply; promoting and investing in diverse and localised waste management; influencing private sector utilities and regulators concerning the capacity and longevity of existing supply and distribution and waste management infrastructure.
	Land and development	Development land	Secure the supply of quality employment land	Ensuring and safeguarding an appropriate supply of quality employment land by providing supportive local and regional plans and policies

2.4 Cross-referencing policy areas objectives and actions between strategies and specifically in relation to the RES

Given the focus of this study on economic impacts and opportunities, the approach has concentrated on understanding how the priority actions of the RES are related to the actions of other strategies. In this respect the links that each strategy has with each RES priority action have been characterised, this process identifies some, moderate or strong links and relevance. In the context of understanding the regional policy priorities, this process assists when identifying how the strategies relate to, and are dependent on, each other and so to ensure that climate change impacts and opportunities are viewed within the correct overall policy vision.

This policy mapping exercise is presented in Appendix B. Linkages between regional strategies are depicted by a coloured box where red boxes indicate the highest degree of linkage and green indicates the lowest. A number of red boxes coincide with Emda's key priority actions (see Table 2.3), highlighting particularly strong linkages between these RES policies and the other sectoral strategies. For example, the key priority action "Growing the Region's Key Sectors" is highly linked to the Regional Water, Waste, Energy, Health and International Trade Strategies. The key priority actions with several highly relevant links to sectoral strategies can be seen in Table 2.3.

Table 2.3 Key Priority Actions within the RES that have Strong Links to Several Sectoral Strategies

Key Priority Action (RES)	Highly relevant links to Sectoral Strategies
Growing the Region's Key Sectors	Water, Waste, Energy, Health, International Trade
Improve Transport Connectivity and Accessibility	Energy, Freight, International Trade, Tourism, Transport
Energy and Waste Capacity	Waste, Energy

The policy mapping exercise identified five RES key priority actions which have not been judged significant in terms of linkages to other regional strategies. These are:

- Develop adult workforce skills;
- Harness a culture of enterprise;
- Targeted provision to improve business creation;
- Commercialising scientific excellence through facilitated business collaboration;
- Secure the supply of high quality employment land.

There are other RES actions that, although not identified by Emda as key, have strong linkages with the suite of regional sectoral strategies. For example, "Maximising the benefit of NEMA and Robin Hood Airport" is strongly related to the Regional Energy, Freight, International Trade, Tourism and Transport Strategies. Other RES actions with four or more strong linkages to sectoral strategies are:

- Maximising the benefit of Nottingham East Midlands Airport and Robin Hood Airport;
- Environmental Infrastructure;
- Supporting infrastructure for housing growth.

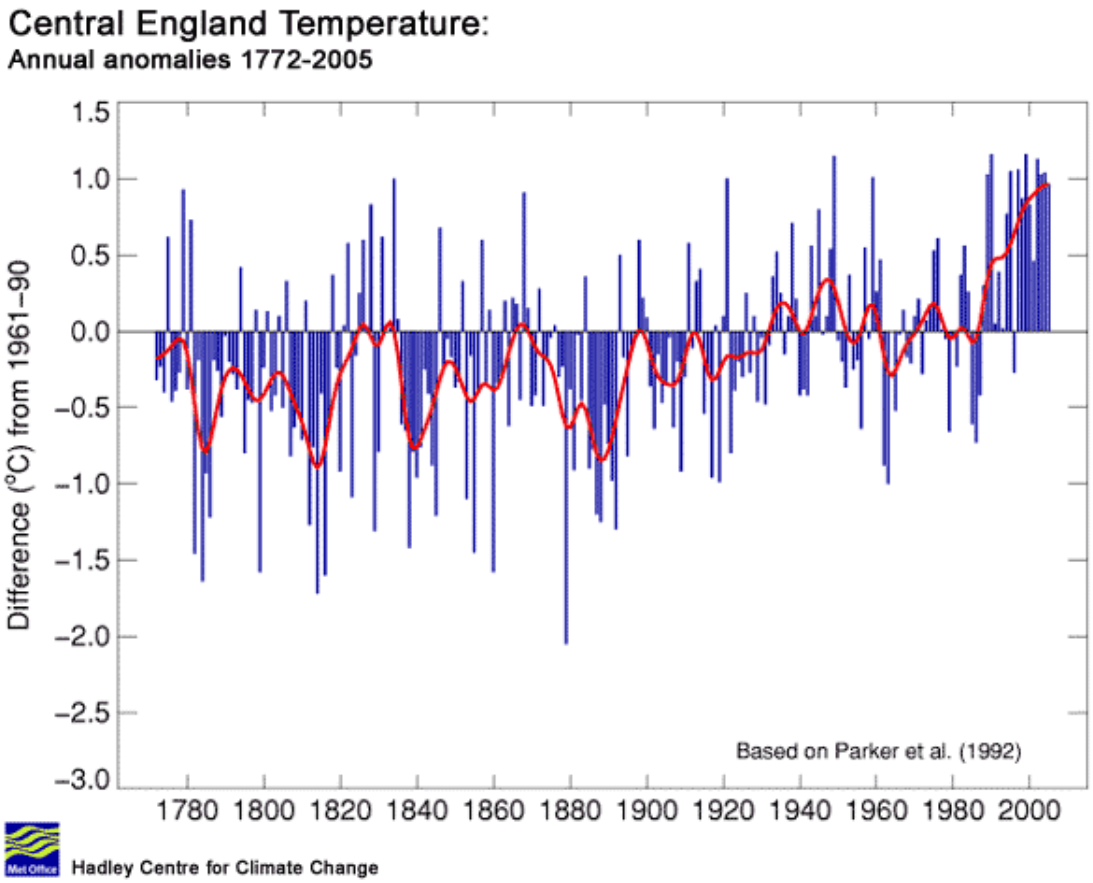
3 Climate Change

3.1 Recent Climate

The East Midlands is a varied region in terms of topography, landscape and environment. As a result, the climate of the Region is also varied; the east of the Region experiences a far more maritime climate than the west. Overall, the climate is relatively stable and few temperature extremes are recoded in the East Midlands.

Within the East Midlands Region there are differences in temperature; at the coast temperatures are influenced by the sea, remaining cooler in summer and warmer in winter then more inland areas. Central England Temperature (CET) is representative of a roughly triangular area of the United Kingdom enclosed by Bristol, Lancashire and London, encompassing part of the East Midlands region (Parker et al. 1992). Records show an increase in temperature in the latter half of the twentieth century, with the largest deviations from the 1961-90 mean all occurring in the 1990s (see Figure 3.1). Temperatures in the Region rose by over 0.5°C during the last century with greatest warming from mid-summer to late autumn (Entec, 2000).

Figure 3.1 Central England Temperature deviation from 1961-90 mean



There are differences in the amount of rainfall received within the East Midlands region. Precipitation is strongly related to topography, with upland areas such as the Peak District receiving more than the lowland fens of Lincolnshire. Near the coast there is an appreciable seasonality to rainfall patterns, with the driest month in spring and the wettest in late autumn. Inland, parts of the Midlands experience a higher frequency of thunderstorms than the national average. Rainfall records exist for Central and Eastern England for the period 1931to present. Annual precipitation has increased slightly (+3%) over this period but it is individual months that show larger departures from the long term average. For example, December totals have increased 38% since the 1930's and July totals have fallen by 31% (Entec, 2000).

As well as influencing rainfall patterns, topography strongly affects wind. There is a close relationship between surface isobars (lines joining points of equal air pressure) and wind speed and direction over open, level terrain such as the Fens. However, in upland areas such as the Peak District, local topography has a significant effect with winds tending to be aligned along well-defined valleys. The most common direction from which the wind blows in England is the south-west, but winds from other directions are quite frequent and long spells of easterly or north-easterly winds are not unusual.

There are no evapotranspiration records in the East Midlands region specifically but the record from the Radcliffe Meteorological Station, Oxford, is thought to be representative of central England (Entec, 2000). Relative to the decade 1900-1910, annual potential evapotranspiration (PET) in the late twentieth century was +3% higher.

3.2 Climate Change

There is now a substantial consensus amongst scientists that human activities are altering the Earth's climate. The recently released IPCC AR4 report concludes that climate change is 'very likely' to have a human cause, indicating a probability of greater than 90% (IPCC, 2007).

The UKCIP02 scenarios forecast the impacts of climate change under a range of emissions scenarios for the UK (Hulme et al., 2002). Scenarios for three different timeslices are presented, representing the average climate over 30 year periods centred on the 2020s, 2050s and 2080s. The climate changes projected to the 2020s are similar across all scenarios; this is because changes in the short term are dictated by past GHG emissions in recent decades. Climate changes beyond the next few decades depend on future emissions, but even the low emissions scenario represents an acceleration of climate change when compared to changes that have occurred in the 20th century The scenarios are based on a UK Met Office General Circulation Model (GCM), coupled to a Regional Climate Model (RCM) which allows impacts to be forecasted on a local to regional scale.

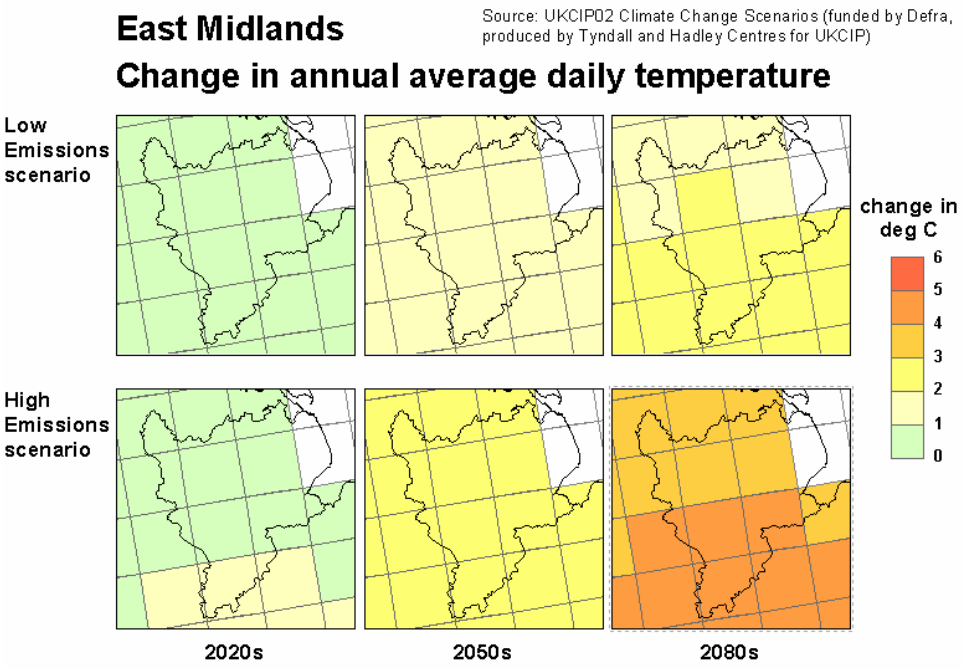
A summary of the major climate changes expected in the East Midlands is provided in Table 3.1, with supporting maps for rainfall and temperature provided in Figure 3.2. All figures are derived from the UKCIP02 scenarios (Hulme et al., 2002) and are expressed relative to the 1961-1990 mean climate. Where a range is given this relates to the low emissions and high emissions scenarios, but also reflects grid-scale geographical variation within the Region. Spring represents the average for March, April and May; summer the average for June, July and August; autumn the average for September, October and November; winter the average for December, January and February.

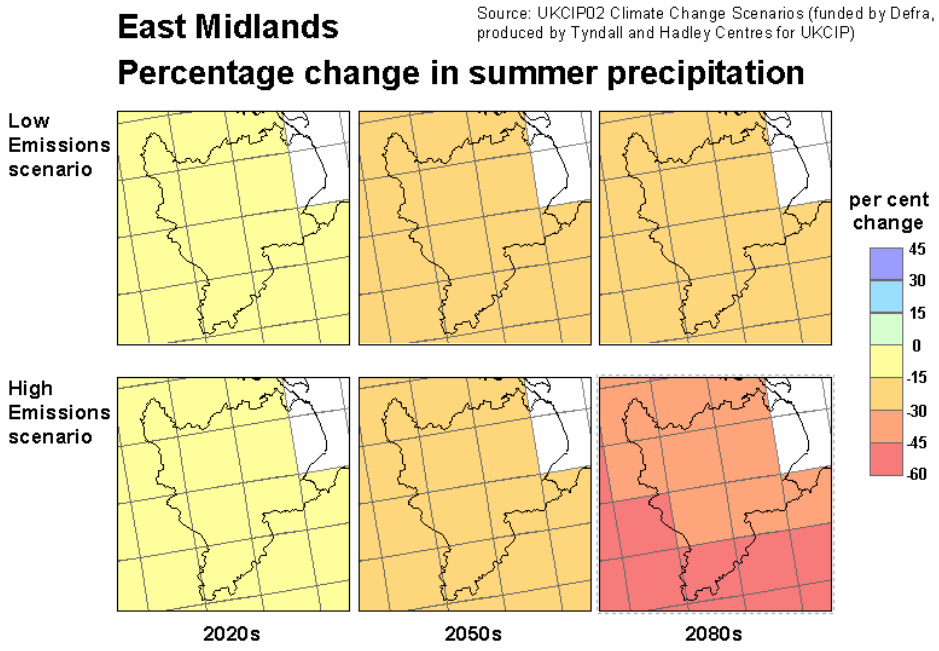
Table 3.1 UKCIP02 Climate Change Scenarios for the East Midlands

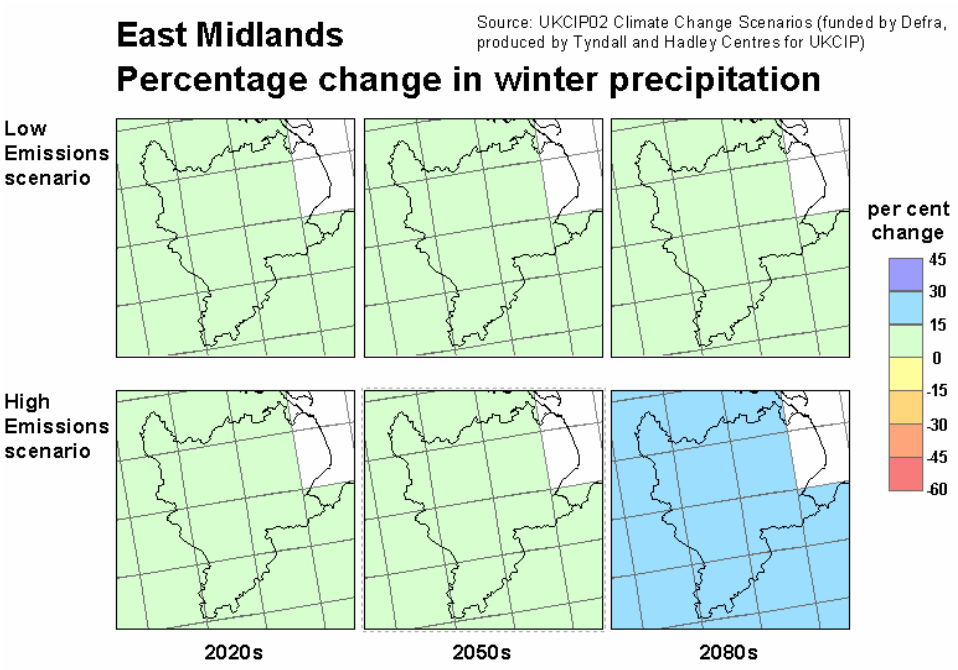
Climate variable		**2020s**	**2050s**	**2080s**
Temperature	Annual mean	+0.5 - +1.0°C	+1.5 - +2.5°C	+2.0 - +4.0°C
	Spring mean	+1°C	+1.5 - +2.0°C	+2.0 - +3.5°C
	Summer mean	+1.0 - +1.5°C	+2.0 - +3.0°C	+2.5 - +4.5°C
	Autumn mean	+1.0 - +1.5°C	+2.0 - +3.0°C	+2.5 - +4.5°C
	Winter mean	+0.5 - +1.0°C	+1.5 - +2.0°C	+1.5 - +3.5°C
	IAV[1]	Annual IAV change is 0 - +10%. Winter and spring temperatures become less variable. Summer and autumn temperatures become more variable.		
	Diurnal range	Decrease in diurnal range in winter, increase in summer. Annual diurnal range change is+0.2 – +0.8°C		
	Extremes	Extremely warm days will become more frequent; extremely warm days will become hotter. Heat waves will be more likely. The number of cold days will decline.		
	Sea temp	Up to +0.5°C	+0.5 -+2.5°C	+1.5 - +3.5°C
Precipitation	Annual mean	WNV[2]	Up to -10%	-10% to -20%
	Spring mean	Up to -10%	Up to -10%	-10% to -20%
	Summer mean	-10% to -20%	-20% to -30%	-30% to -50%
	Autumn mean	Up to -10%	Up to -10%	-10% to -20%
	Winter mean	Up to +10%	+10% to +20%	+15% to +30%
	IAV	Annual IAV change in the range +5% to +15% Increase in winter precipitation variability in eastern England. Decrease in summer precipitation variability.		
	Snow	Average winter snowfall is likely to decline by between –50% and –100% (i.e. no snow on average) by the 2080s		
	Extremes	More intense rainfall days in winter and spring. Greater probability that an extreme rainfall event will occur on any given winter day. Evidence that intense summer storms may also increase (but limited by spatial resolution of model). Seasonally, there is an increased likelihood of very dry summers and very wet winters		
Cloud cover		Annual change in cloud cover of -6% to -9%. Large decreases in summer cloud cover, -9% to -18%. Slight increase of up to 3% in winter.		
Relative humidity		Relative humidity will reduce annually and in all seasons, especially in summer -9% to -15%		
Soil moisture content		Soils will become drier overall, with soil moisture content declining by as much as 50% in some areas by the 2080s (high emissions). Soil moisture content will actually increase marginally in winter, but this is offset by significant reductions in summer and autumn.		
Wind speed		Average wind speeds over land are likely to increase in winter and spring up to +7% but may decline in summer and autumn up to -7%. However, changes in wind speed are only predicted with low confidence		
Sea level		Global mean sea level is expected to rise by between 9 and 69 cm by the 2080s (the range represents emissions and scientific uncertainty). Regional figures incorporating isostatic uplift suggest a relative mean sea level of between 8 and 77cm by the 2080's. Storm surge heights in the Wash are anticipated to increase up to 1.2m beyond the addition of mean relative sea level. However, changes in storm surge heights are only predicted with low – medium confidence		

[1] IAV = Inter annual variability. Based on model output for 2080s across the four UKCIP02 scenarios.
[2] WNV = within a measure of Natural Variability i.e. no trend detected.

Figure 3.2 UKCIP02 scenarios for the East Midlands (Hulme et al., 2002)







A new set of climate change scenarios is due to be published by UKCIP in 2008. The UKCIP08 scenarios, will provide users with a greater range of outputs. In addition, the scenarios will be presented as a probability density function, rather than a single number, with the probability representing some of the uncertainties inherent in climate modelling, downscaling and in relation to natural variability. However, the outputs will still be subject to uncertainty related to elements of the climate system poorly represented by climate models and uncertainties beyond the modelling process will not be captured. In particular this will still mean that separate emissions scenarios are required for the 2050's and 2080's timeslices. Nonetheless, the new scenarios will represent a significant development.

3.3 Climate Change Uncertainties

There are several uncertainties associated with future climate change scenarios. These need to be considered when assessing climate change impacts and risks, and when defining strategies and options for adaptation. Table 3.2 summarises the key uncertainties. A detailed review of uncertainties in relation to the UKCIP02 scenarios is provided in Chapter 7 of Hulme et al. (2002).

Table 3.2 Key Climate Change Uncertainties

Uncertainty	Description
Emissions	Results from uncertainty about future socio-economic developments and consequences for emissions.
Climate sensitivity and climate modelling	The response of the climate to emissions varies between GCMs caused by different representation of physical processes. Climate models do not perfectly represent the climate system, some aspects of which are particularly uncertain e.g. feedback mechanisms which may trigger rapid climate change.

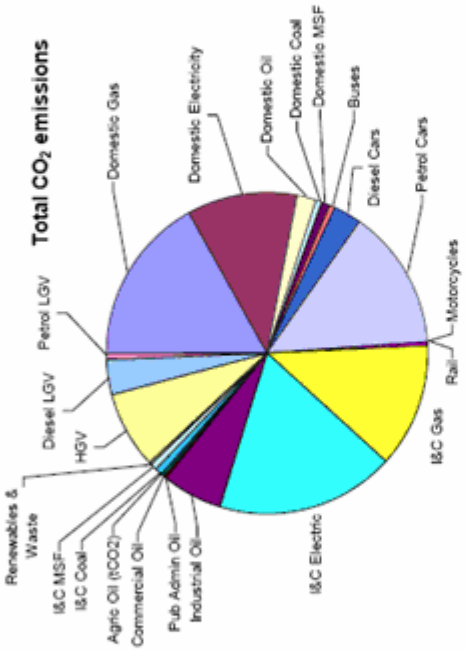
Uncertainty	Description
Downscaling global changes to the local level	The process of downscaling changes in global or large-scale climate to the regional or local level is complex and must also consider natural variability and change (e.g. isostatic uplift, which strongly influences mean sea level rise).
Impact	Assessing the effects on climate change in impact models (e.g. hydrologic models) and in other evaluations (e.g. costing or consultation exercises) introduces further uncertainty.

4 Mitigation

4.1 Introduction

While GHG emissions have, and will continue to be, driven by economic growth; stabilisation of GHG concentration is feasible and consistent with continued growth (Stern, 2006). The Intergovernmental Panel on Climate Change (IPCC) define mitigation as 'an anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases' (IPCC, 2001). The majority of international, national and regional legislation on the subject of climate change has been concerned with mitigation and specifically the reduction of greenhouse gas emissions.

The first step towards mitigating emissions is to calculate a baseline. The East Midlands region has conducted a study to measure the carbon footprint of the region (Simmons and Gonzalez, 2006). Figure 4.1, breaks down the Region's inventory of emissions by sectors and is referred to throughout the following sections.



Petrol LGV	146,648
Diesel LGV	1,259,878
HGV	2,706,302
Renews & Waste	86,137
I&C MSF	161,914
I&C Coal	288,808
Agric Oil	39,183
Commercial Oil	90,934
Pub Admin Oil	97,426
Industrial Oil	2,029,437
I&C Electric	6,197,651
I&C Gas	4,275,785
Rail	107,201
Motorcycles	34,391
Petrol Cars	4,817,083
Diesel Cars	942,601
Buses	240,027
Domestic MSF	193,758
Domestic Coal	206,288
Domestic Oil	707,808
Domestic Electricity	3,752,831
Domestic Gas	5,834,537

Table 10: Tonnes of CO_2 by source (data refers to pie above)

Figure 4.1 Breakdown of East Midlands CO_2 emissions by sector

4.2 Water Resources

4.2.1 Relevance to mitigation

Climate change is likely to have a significant effect on water resources in the East Midlands in the future (Waters, 2004). Hotter and drier summers may lead to an increase in drought conditions with knock on effects on water supply. The impacts of climate change will require adaptive action in the water resources sector although, in addition, there are opportunities to mitigate GHG emissions.

The cleaning and transportation of wastewater are energy intensive processes and water and sewage companies are growing increasingly aware of the need to become more energy efficient (see Figure 4.2).

Figure 4.2 CO_2 emissions and energy use per litre of water supplied and treated (WaterUK, 2006)

Emissions of greenhouse gases

Indicator	Result 2004/2005	Result 2005/2006	Progress
Greenhouse gases emitted • total (tonnes)	4.14m	4.15m	↔
• in supplying1Ml water	0.249 tonnes	0.289 tonnes	↓
• in treating 1Ml sewage	0.641tonnes	0.406 tonnes	↑
• CO2 from road transport	0.00183 t/p	0.0017 t/p	↑

Use of Energy

Indicator	Result 2004/2005	Result 2005/2006	Progress
Energy used • total (GWh)	8,110	7,703	↑
• supply1Ml water	663kWh	586kWh	↑
• treat 1Ml sewage	663kWh	634kWh	↑
Renewable energy • used	8.45%	14%	↑
• generated	392GWh	493GWh	↑

In December 2006, Water UK, the body representing the water industry in the UK, released a report entitled 'Towards Sustainability 2005-2006' which highlighted a number of practices water and sewage companies can employ to become more sustainable, including mitigation actions. Progress has been made in reducing the amount of energy required to produce 1Ml of drinking water and treat 1Ml of sewage and the proportion of renewable energy used by water and sewage companies is increasing (WaterUK, 2006). There is scope to improve these further and reverse the negative trend in GHG emissions generated per litre of drinking water supplied.

The second contribution the water industry can make to mitigating emissions is in energy production from sewage. Sewage sludge can be used directly or indirectly to generate renewable energy. Sludge can be spread on land to grow energy crops for biodiesel or can be used directly in processes such as gasification.

4.2.2 Influence of existing policy

The introduction of the European Union Emissions Trading Scheme (EU ETS) represents an extra cost for intensive energy installations and has led to the engagement of the water industry in energy efficiency. If the scheme was extended to all major energy users water and sewage companies would face increased costs and as such are already beginning to look at ways of reducing

their energy demand. The Renewables Obligation (RO) is also an impetus for water and sewage companies to investigate the feasibility of energy from waste solutions, providing the opportunity to gain economically from obtaining Renewable Obligation Certificates (ROCs). At a Regional scale, there are no energy efficiency policies specific to the water industry but general policies to reduce industrial energy use do apply. Policies ENG7 in the Regional Energy Strategy address energy efficiency in industry and ENG10 and 11 aim to increase the use of renewable energy in the Region.

4.3 Flood Management

4.3.1 Importance of mitigation

Adaptation rather than mitigation is of primary importance in this sector although there are measures that can be taken to reduce GHG emissions. Currently, the majority of materials used to construct hard flood defences are highly energy intensive to produce, resulting in significant GHG emissions. The production of 1 tonne of concrete results in the release of 1 tonne of carbon dioxide into our atmosphere (UEA, 2006). Switching to alternative materials with lower emissions associated with their lifecycle could reduce emissions generated indirectly by the flood management sector.

In addition to traditional hard engineering structures as an approach to flood defence, land use change and managed retreat is becoming increasingly popular as a method to reduce flood risk. Such approaches require little or no construction materials and can therefore offer significant emissions reductions.

4.3.2 Policy Influence

There does not appear to be a policy at any scale that addresses the use of sustainable materials in construction of flood defences directly. However, indirect impacts from other policies may affect the choice of materials in favour of less energy intensive products. The choice of materials may indirectly be affected by the introduction of the EU ETS. The cement industry is currently covered by the scheme and manufacturers have reported a reduction in competitiveness with producers outside the EU since the scheme commenced (CEMBUREAU, 2006). This has resulted in price rises, making cement a less attractive material to consumers. The introduction of the EU ETS therefore has the effect of stimulating markets for less emissions intensive products. This represents a significant opportunity to producers of products such as foamed concrete or timber growers who can now begin to compete with traditional material for flood defences.

There is currently extensive policy support for land use change as an approach to managing flood risk. Defra's policy 'Making Space for Water' is the UK policy response to the European Union Water Framework Directive which advocates the creation of wetlands in a flood defence capacity. The Regional Flood Risk Appraisal recognises managed realignment as a potential approach to flood defence at the coast (Emra, 2006a). While Policy 36 in the Regional Spatial Strategy (RSS) states that "Development Plans, future Local Development Frameworks, and strategies of relevant agencies should…deliver a programme of flood management schemes that also maximise biodiversity and other regeneration benefits" (GOEM, 2005).

A recent managed retreat scheme at Freiston Shore, Lincolnshire is an example of a flood management project in the East midlands which has contributed to GHG abatement by not using energy intensive products. In 2000, part of the sea bank was purposely breached, taking the pressure off the remaining sea defences, with the aim of prolonging their life. Sixty-six hectares of tidal saltmarsh is now re-establishing itself, helping to soak up wave energy and acting as a sea defence.

4.4 Biodiversity and Conservation

4.4.1 Importance of mitigation

It will be necessary to take action to mitigate against the impacts of climate change in the conservation sector, although it is not a sector where significant actions to mitigate GHG emissions can be taken. However, the importance of land use change and conservation management practices in this sector should be noted. Creation of wetlands and flood plain forests, for example, provide excellent habitats for a range of species and contributes to mitigation as they lock up carbon. Conservation practices (e.g. burning; grazing; felling; coppicing) can impact on carbon fluxes and reservoirs and conservation mangers should consider these when selecting management regimes.

In the East Midlands region, peat bogs could be a significant potential source of carbon dioxide as climate becomes warmer and drier (Entec, 2000). Brown water containing carbon is lost from peat bogs in greater quantities where there are drainage ditches, thus making it possible to mitigate losses by blocking channels (Worrall et al., 2003).

4.4.2 Policy Influence

Wetlands are Biodiversity Action Plan (BAP) habitats and as such are afforded special protection. Defra have set the Environment Agency a high level target obliging them to prevent the loss of BAP habitats and to create more where opportunities arise. In the Environment Agency Midlands region (encompassing East and West Midlands) 56.4ha of BAP habitat (reedbed and grazing marsh) has been gained (Environment Agency, 2006).

The Regions Forestry Strategy, Space4trees, recognises the importance of trees in mitigating GHG emissions and other environmental issues, stating that “management of air, soil and water helps to lock up carbon from the atmosphere, trap air and water borne pollution, clean up contaminated land and offset the impacts of flooding” (Space4trees, 2005). Policies to increase woodland cover, in particular floodplain forests, are included in the Strategy. Major efforts have been made to increase the woodland cover of the East Midlands, particularly in the former coal mining areas of Nottinghamshire, Leicestershire and Derbyshire. Over the last decade over 7000 hectares have been planted with Forestry Commission support (ibid).

4.5 Agriculture, Horticulture and Forestry

4.5.1 Importance of mitigation

Farming is now the biggest source of two important greenhouse gases; nitrous oxide and methane. The digestive processes of grazing animals (mainly cows) release about 35 per cent of total UK methane emissions. Soils and fertiliser use are the source of two-thirds of nitrous oxide emissions in the UK (Environment Agency, 2006). In the East Midlands, agriculture (livestock and non-livestock) is responsible for 6% of all greenhouse gas emissions, not just methane and nitrous oxide (Entec, 2000).

There is an opportunity for agriculture to assist in the mitigation of climate change through a switch to renewable energy. Crops such as miscanthus (elephant grass) can be grown and used as fuel in a carbon neutral process of electricity generation and biodiesel can be used to power vehicles.

Farmers can also reduce carbon emissions by changing their fertiliser use and tillage practices (Environment Agency, 2006). Adding nitrogenous fertilisers boosts plant growth, but some of the nitrogen is released to the atmosphere as nitrous

oxide, a gas with 310 times the global warming potential of carbon dioxide. Switching to organic fertilisers reduces this effect. In addition, organic farms have been found to be much better at sequestering carbon (Gee, 1998) and as such, organic farming appears to have a contribution to make to mitigation. However, the Environment Agency is currently recommending that more research is carried out into the role of the soil carbon store in mitigating climate change (Environment Agency, 2006).

Action to mitigate climate change presents a prospective opportunity for the forestry sector, potentially increasing the demand for wood and wood based products. Wood can be grown directly for carbon neutral energy production, often as short rotation coppice poplar or willow. Alternatively, thinnings or forest residues can be used as fuel in bioenergy plants, thus reducing carbon dioxide emissions from the electricity generating sector. There is also potential to use wood as a substitute for other materials, such as concrete and steel, which have high energy requirements associated with their production.

4.5.2 Policy influence

There are policies at the national and regional level that offer support to agriculture and forestry projects aimed at growing fuel for bio energy production. The Renewable Transport Fuel Obligation (RTFO), Renewables Obligation (RO) and Energy White Paper provide an impetus to switch to bio fuel crops. This includes financial support available from national government in the form of a 20p per litre duty differential for biodiesel, guaranteed for three years. A number of policies in the Regional Environmental Strategy and Regional Energy Strategy support the development of energy crops to fuel renewable power and heat generation in the East Midlands; in particular, ENV8 from the Regional Environmental Strategy and ENG9, ENG10, ENG11 and ENG16 from the Regional Energy Strategy. Crop switching to bio fuel plants represents an opportunity for farmers to take action in mitigating GHG emissions but also adapting to changes in growing conditions.

Growing biofuels is a relatively new concept in the East Midlands and to date most activity has been aimed at increasing awareness amongst farmers. There is a regional effort to deliver Defra's Strategy for Sustainable Farming and Food in the East Midlands and this involves promoting biofuels. Farmers from across the region discussed the future for renewable energy at a conference entitled 'The Potential for Biofuels' in February 2006. A website (http://www.bioenergygroup.org) has been set up with an online searchable database allowing visitors to access to details about fuel suppliers and boiler installers and case studies which tell of the experiences of people who have installed wood fuel systems.

There has been some activity in the forestry sector in East Midlands with respect to renewable fuels. Four schools have trialled a wood heating scheme (Emra, 2004) with the fuel supplied from sites within the region. In the East Midlands there is now a significant amount of activity to promote and install wood fuelled heating systems and to develop the fuel supply chain and capacity (space4trees, 2005). The Forestry Commission appointed a Wood-fuel Coordinator in 2005 to work with farmers, landowners and other energy users, to identify ways to develop wood fuel as an alternative energy source across the East Midlands. Awareness is also being raised at a local scale with events such as the 'Green Heat in Lincolnshire: Renewable Energy from Wood' conference.

4.6 Energy

4.6.1 Importance of mitigation

As a sector, the energy industry is responsible for the largest proportion of greenhouse gases emitted in the UK (Defra 2006a). In 2004, 56 million tonnes of greenhouse gases (or 37% of the total UK emissions) were emitted by the energy industry. As a result, there is considerable scope to mitigate climate change by reducing GHG emissions from the energy sector using a two pronged approach; 'greening' supply and reducing demand.

The East Midlands is an important region in the UK for electricity generation and given its industrial heritage, is heavily dependent on coal fired power stations. As a result, per capita carbon dioxide emissions are higher than other UK regions. There are significant opportunities to develop renewable energy; the region is richly endowed in potential resources, particularly off shore wind.

4.6.2 Policy influence

As can be seen in Appendix A, there is a plethora of policies that impact on the energy sector. In terms of energy supply, the most influential policy at European level is the EU ETS. As is the case with many of the policies affecting the energy sector, the EU ETS represents a threat to some stakeholders and an opportunity to others. A similar effect is seen at a national level: the RO and the Energy White Paper, for example, represent direct economic opportunities to new renewable electricity, Combined Heat and Power (CHP) and nuclear power but may threaten the traditional fossil fuel generated energy market. This threat is particularly significant for the East Midlands as there is a concentration of coal fired power stations in the region, accounting for 10-15% of the UK's generating capacity (Emra, 2002).

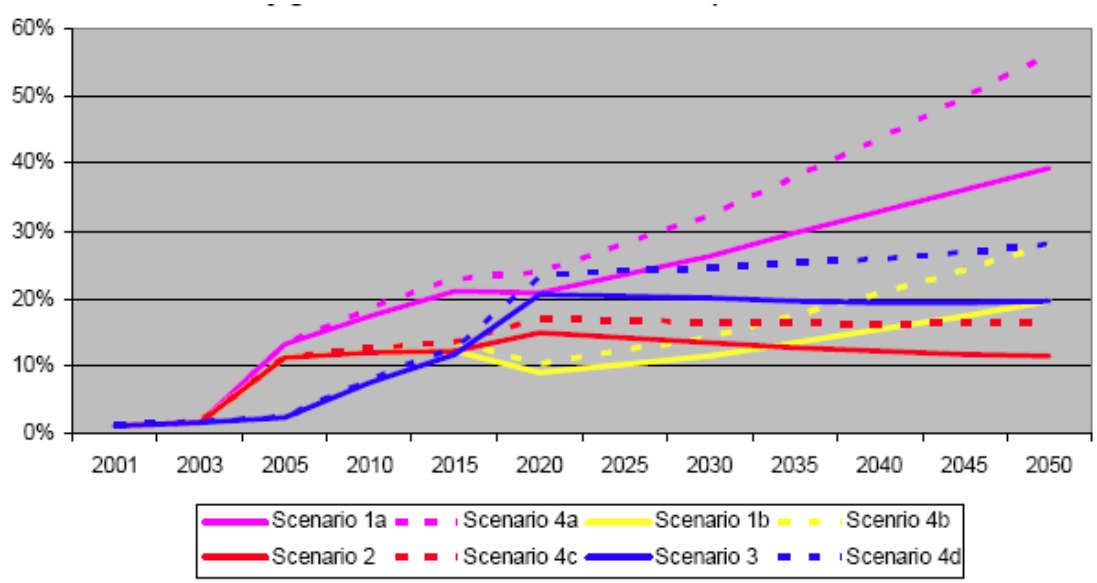
At a regional level, the RES follows national policy making and adopts an energy hierarchy which acknowledges the need to use less energy (EMRA, 2006b). Priorities are set out in the following order:

- Reducing the need for energy;
- Using energy more efficiency;
- Using energy from renewable sources;
- Making clean and efficient use of fossil fuels;

The Region has also developed a range of scenarios, looking at the role of different energy mixes in meeting the UK target of a 20% reduction in CO_2 by 2010 (see Figure 4.3).

There is policy support for renewable electricity generation and CHP in the form of infrastructure and market and research development. There has been one off-shore wind farm approved in the East Midlands region; Inner Dowsing at Ingoldmells and a 16-turbine site is operational at Mablethorpe, Lincolnshire. The Mablethorpe wind park will provide enough electricity to power almost 10,000 local homes (ecotricity 2003), thus making a significant contribution to Lincolnshire County Council's target to provide 10% of its power from renewable sources by 2010. The Region as a whole has a target of 8.3% of all electricity to be generated from renewable sources by 2010 (Emra, 2006c).

Figure 4.3 Percentage of renewables in the energy mix of the East Midlands under different scenarios (Simmons and Gonzalez, 2006)



However, the planning policy may be a threat to the development of renewable energy in the Region, which, although superficially supportive of renewable energy, may hinder the development of generation sites in practice. A 20-turbine site at Connisholme, Lincolnshire was initially refused planning permission and it took four years to get approval. Few companies would be able to wait four years for planning permission and it is likely that they would either give up or move to another region. Although there is apparently policy support for renewable energy in the East Midlands, the region has the third lowest number of renewable energy generation sites amongst all the English regions (Emra, 2006c).

Since 2003 there have been several significant solar PV installations around the region, the largest being Queen's Park Sports Centre at 101 kWp and the development on housing in Braunstone in Leicester at 70 kWp. The total capacity is hard to determine exactly, as it is extremely dispersed (Emra, 2006c).

Demand management is the second key tenet of policies to mitigate climate change in the energy sector. There is policy support for measures to reduce consumer energy demand and increase energy efficiency at all scales in the East Midlands. The majority of action to implement policies at a regional level has been in the field of awareness raising and advice. There is an Energy Saving Trust Energy Efficiency Advice centre in Leicester offering domestic energy saving advice. The Carbon Trust provides a similar service for business energy users and, in addition, Emda has set up a website called EMBREN (East Midlands Business Resource Efficiency Network) which provides businesses with advice on how to increase profits through energy efficiency.

Local authorities are particularly active in energy efficiency and of specific note in this field is Newark and Sherwood District Council. The Council can demonstrate a long standing commitment to tackling fuel poverty through their property based approach; improving the energy efficiency of the worst dwellings. In 1988 the authority established a 20-year (£16.4million) energy efficiency investment programme for its 7,500 council-owned dwellings. As the approach is widely based around energy efficiency measures it also helps reduce the district CO_2 emissions. The method has involved working in strategic partnership with agencies such as Age Concern, Care and Repair and other partners in the health and social service sector.

4.7 Transport

4.7.1 Importance of mitigation

Transport is a major generator of GHGs, responsible for emissions of carbon dioxide and nitrous oxide. Transport is one of a few UK sectors where GHG emissions are increasing (ONS, 2005). Greenhouse gas emissions from transport increased 5.2 per cent between 2002 and 2003. The majority of emissions in this sector come form road transport; 21% of total UK carbon dioxide emissions. The main opportunities for mitigation in the transport sector are modal shift away from private vehicles, demand reduction and alternative fuels.

Road transport accounted for approximately 30% carbon dioxide emissions in the East Midlands in 2004 (Simmons and Gonzalez, 2006) and traffic levels are increasing (Emra, 2006d). The proportion of people using public transport in the Region is lower than the national average (Emra, 2006d), indicating that there is scope to improve uptake in the East Midlands. Freight and distribution are important to the regions economy due to its location in the centre of the country and proximity to major infrastructure routes. Currently, the predominate mode of freight transport is road but there are opportunities to switch to rail or water, particularly as the region is well endowed with canals.

Air transport is an increasing source of GHG emissions globally. The UK is no exception and between 1990 and 2004, emissions from aviation fuel use more than doubled (Defra 2006a). Emissions at high altitude have a significantly greater greenhouse effect than that of near-ground based emissions and as such, efforts to reduce flights contribute significantly to mitigation of climate change. The East Midlands region is home to Nottingham East Midlands airport which serves passenger and freight requirements.

4.7.2 Policy influence

Although the EU ETS does not directly affect the transport sector at present, the UK government is pushing for the inclusion of road and air transport in the scheme. It has also signalled it's commitment to road pricing in the Transport White Paper. This will have a significant effect on the sector representing a threat to road users in terms of increased prices. The introduction of road pricing could be a significant threat in the East Midlands where there is a large manufacturing base reliant on road freight (GOEM, 2005). To date there have been no moves to introduce road pricing in the region.

The inclusion of air transport in the EU ETS could also be a significant threat to transport in the East Midlands due to the prominence of Nottingham East Midlands Airport. Companies using air freight could be considerably affected and passengers would also face higher travel costs if aviation was to be included in the EU ETS. Although the UK supports inclusion of aviation in the ETS and current national policy is in favour of increasing airport capacity (Defra, 2003), increased prices may reduce demand. Forecast demand, the basis of airport expansion policy, may therefore be less than expected.

The East Midlands region is currently committed to providing for further expansion at Nottingham East Midlands airport (GOEM, 2005), which has seen a 100% increase in the number of air transport movements between 1993 and 2003 (EMRA 2006a). This is in stark contrast to the commitment "to reduce the scale and impact of climate change" (GOEM, 2005). There is going to be increasing conflict between priorities regarding air transport and reducing emissions in the Region if the policy to expand the airport is perpetuated. A recent publication "East Midlands Airport Master Plan" announced a new commitment to make its site operations 'carbon neutral' by 2012, however, the reductions made on the ground

will be offset and exceeded by those emitted in the air. As it stands, policy will have a negative effect on emissions from the region.

International, national and regional transport policies represent a significant opportunity for many stakeholders in the transport sector. Targets and aspirations to increase the number of journeys made by public transport abound in policy documents and there is financial support available to implement them. In the East Midlands a Smarter Choices website has been set up by Emra in response to the Department for Transport (DfT) report 'Smarter Choices - Changing the Way We Travel' (Cairns et al., 2004). The website is aimed at promoting sustainable transport by providing information about a number of initiatives that have been rolled out across the region. These include workplace, school and residential travel plans, teleconferencing, car clubs and better public transport information.

There has been considerable success in attracting people to the railways in the East Midlands. The Region has the highest growth rate for rail passengers for all the English regions, with a 60% increase between 1995/96 and 2004/05, (EMRA 2006a). One of the flagship public transport projects in the East Midlands is the Nottingham Express Transit, a tram system opened in 2004. It is integrated with the bus system and park and ride scheme in the city and has been successful in attracting high numbers of passengers, exceeding predictions (Railway Strategies 2005). Second and third lines are now under construction.

The Regional Transport Strategy (RTS) includes policies on car parking as an instrument to reduce the number of journeys made by car. There is a presumption against increasing numbers of car parking spaces associated with new developments unless other modes of transport are not available or on-street parking is proven to be having a negative effect on highway safety or residential amenity (GOEM, 2005).

Regional transport policy supports the provision of walking and cycling as a means of changing people's travel behaviour. However, it places the onus for delivery on local authorities, "Development Plans, future Local Development Frameworks and Local Transport Plans should also include measures to encourage an increase in walking and cycling. Such measures should include the provision of safe routes, convenient access to buildings and sufficient secure cycle parking in new developments" (GOEM, 2005). For example, Leicester City Council has rolled out a programme of events and infrastructure to support cycling, including monthly workshops, cycle parking grants to employers and the Leicester Bike Park (Environ 2005). The Bike Park is the largest dedicated cycle park in the UK with facilities for 120 cycles including lockers, showers, changing facilities, workshop and a cycle hire shop. Derby City Council was one of six council to win funding from DfT as part of the Cycling Demonstration Town initiative. The city has four after school cycling clubs, providing children with a bike and a cycling coach and has instigated a BikeSafe scheme with the aim of ensuring that all Key Stage 2 pupils will have undertaken cycle training by the time they leave primary school.

4.8 Manufacturing, Industry and Services

4.8.1 Importance of mitigation

Manufacturing, industry and services covers a wide range of activities from the traditional coal mining and metal working to modern service industries such as banking and insurance. However, activities and processes included in this sector are responsible for emitting all of the gases incorporated in the Kyoto 'basket' of greenhouse gases. Defra statistics for the UK separate energy industries from other types of industry, resulting in an emissions figure of 27 million tonnes CO_2 in 2004.

The East Midlands has a larger manufacturing base than the UK average with a concentration of traditional manufacturing sectors; mining, fuel processing, metals, minerals, transport equipment and textiles. These traditional industries tend to be energy intensive. The particular strategic situation of the East Midlands at the focus of the national highway network means there is a concentration of retail distribution centres especially in the Region's Southern Sub-Area. The Region is under-represented in such growth sectors as communications, finance, business services, property and electronic engineering.

The main mitigation strategies in this sector are increased energy efficiency in production, a modal shift away from road freight transport and increasing tele-working opportunities.

4.8.2 Policy influence

There are a number of threats to the manufacturing, industry and service sector in the East Midlands as a result of policy statements. The EU ETS and the UK Climate Change Levy (CCL) represent significant additional cost to many manufacturing businesses, on which the East Midlands economy is heavily reliant. There is however, scope for some companies to make money by selling excess allowances.

National and regional transport policy may pose a threat to the manufacturing and industry sectors which are heavily reliant on road transport to move materials and finished products. There is a strong presumption against road freight and policies such as the lorry road user charge would significantly impact on those companies that choose to continue using this method of transport. The RTS stipulates sub-regional policies for freight, targeting the food and drink industry in the Eastern Sub-Area, the quarrying and aggregates sector in the peak sub-area and the freight distribution sector in the Southern Sub-Area (GOEM, 2005). These policies are reinforced in the Regional Freight Strategy (EMRA, 2005).

Climate change mitigation policy represents a significant opportunity to develop the service industry in the East Midlands. Increasing amounts of legislation and policies relating to mitigation mean that there is a market for people with skills to interpret and implement them. Standards such as the Building Regulations and the Code for Sustainable Homes require trained people to carry out inspections of new developments, and the EU ETS requires independent verifiers to check accounts. Employment in the growing environmental service industry can be boosted as a result of mitigation polices. As a result, the Environmental Industries East midlands forum has been set up, aiming to bring together environmental goods and service sector suppliers, their customers, research institutions, funding organisations, public sector support agencies and other key stakeholders to further the aims and interests of the sector.

Increasing energy efficiency in the manufacturing and industrial sectors is a strong theme throughout many mitigation policies. Improvement in energy efficiency is a direct requirement of the Climate Change Agreements and is encouraged by instruments such as the CCL, the EU ETS and the Regional Energy Strategy. Increasing energy efficiency may initially require a capital outlay to purchase new equipment or technology but there are potential savings for companies in the long term. On behalf of Emda, a company called Pera is co-ordinating a programme designed to assist East Midlands based Small and Medium-sized Enterprises (SMEs) to improve their energy efficiency whilst enhancing profitability and competitiveness. 120 companies will be offered the opportunity to benefit from a comprehensive on site survey aimed at identifying key areas where energy efficiency can be improved. Fifty companies will then be offered support in obtaining grant funding from Emda to assist in meeting the costs associated with undertaking the recommended improvements. Examples of this could include

replacing an old inefficient boiler, improving insulation on premises or modifying production methods to reduce energy usage.

In addition to this scheme, the Carbon Trust is working with businesses and industrial users of energy to reduce their energy demand and help them become more efficient; together with East Midlands Electricity plc they have run energy management courses aimed at increasing energy efficiency in small companies. The Carbon Trust is also supporting research and development into energy efficiency in the region; Loughborough University and Weatherite Manufacturing Ltd. were nominated for the Carbon Trust's national Innovation Awards for the development of an air-conditioning system which is safe, pollutant-free and reduces the electricity consumption of traditional air-conditioning installations by 50 per cent (Carbon Trust, 2003).

As well as focusing on process emissions form industry, policy addresses emissions from buildings including factories and offices. The Building Regulations, in particular Part L – Conservation of Fuel and Power, require new office and commercial developments to "limit heat gain and losses through thermal elements and fabric; provide energy efficient fixed building services; provide the owner with sufficient information so that the building can be operated in such a manner as to use no more fuel and power than is reasonable" (ODPM, 2006). There are many actions that can be taken to improve efficiency; take advantage of natural light and shade sources, turn electrical equipment off stand-by, improve insulation and use sustainable construction materials. An example of sustainable office development in the East midlands is the Whittle Hill Farm buildings, home to Beacon Energy. Work was carried out to restore and convert 250m^2 of obsolete farm buildings into offices in a way that was sympathetic to the environment. The design included insulation, external, adjustable louvres to cool the building in summer and allow natural light in during the winter and a covered solar walkway designed as a passive solar heat collector.

4.9 Built Environment and Planning

4.9.1 Importance of mitigation

Emissions from the built environment come from a variety of sources; heating and cooling, lighting and materials, for example. One of the biggest contributors to greenhouse gas emissions in the sector is domestic properties: in 2004 16% of all UK carbon dioxide emissions came from residential dwellings (Defra, 2006a).

Currently, domestic emissions account for approximately a third of the total CO_2 emissions for the East Midlands region (see Figure 4.4). Planning has an important role to play in mitigating climate change by encouraging use of more sustainable and less energy intensive materials and designs and promoting energy efficiency in all new buildings. There is also a substantial opportunity to increase the efficiency of existing buildings, reducing their energy requirements and resulting greenhouse gas emissions. Spatial planning also has a role to play in reducing the distance people need to travel to access home, work and leisure facilities, thus reducing emissions from transport.

4.9.2 Policy influence

Policy on energy efficiency in buildings comes down from European level, through national legislation and is well represented by regional policy. The main policy instrument at a national scale is the Building Regulations although these are not particularly stringent on standards of energy and water efficiency. There are a number of national standards that developers can sign up for voluntarily, although it is possible that the Code for Sustainable Homes will be made mandatory in future. Developers may see these polices as an economic threat as they will have

to develop new construction techniques and use more expensive materials, although these may be passed onto consumers. For residents and housing associations there is an opportunity to save money through reduced running costs. A further benefit, announced at the last budget, is that zero carbon homes will be exempt from stamp duty.

The forthcoming Emda report "Delivering Sustainable Communities in the East Midlands" will address the objective of the Regional Spatial Strategy (RSS 8) which aims "to promote and ensure high standards of sustainable design and construction, optimising the reuse of previously developed land and buildings" (GOEM, 2005). Sustainable development is also a key part of the Regional Housing Strategy. Specific policies are included to ensure that new developments are of a high quality housing design which enhance the quality of the local environment and use sustainable construction and design techniques.

Although a number of strategies incorporating sustainable development policies have been published, the RSS contains no policies directly aimed at encouraging the use of sustainable building materials and design. As a result there has been much discussion but little action in the East Midlands to change mainstream construction practices.

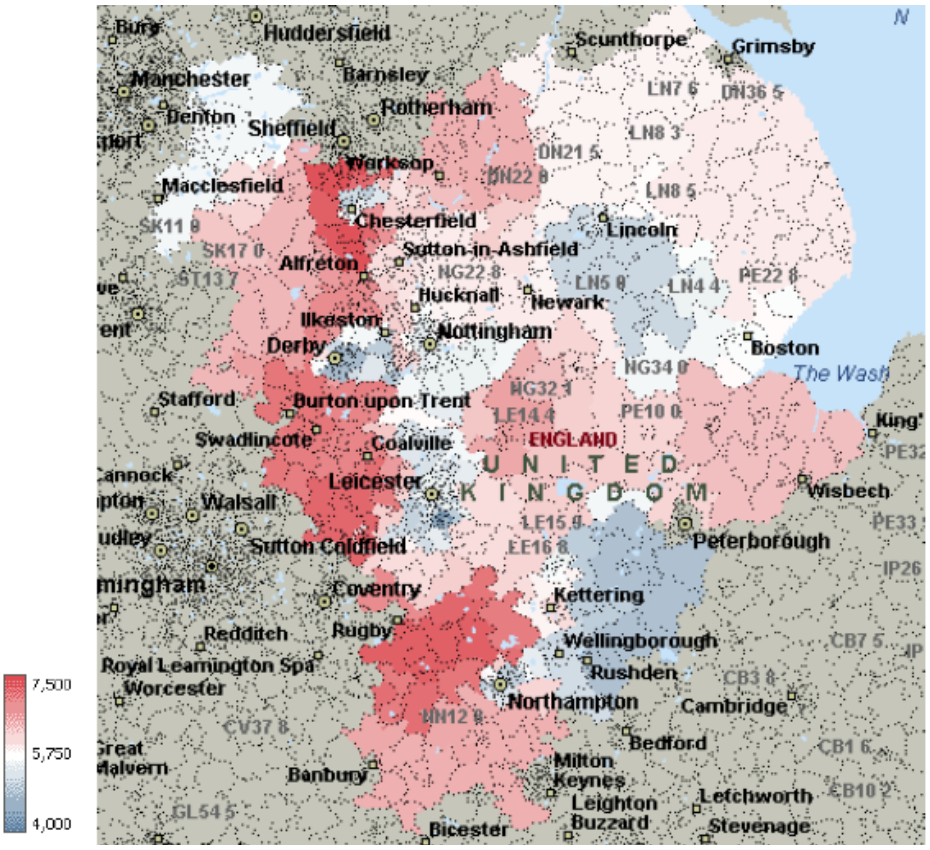
There has been some attempt to raise awareness of the importance of sustainable construction and development. The East Midlands Centre for the Built Environment (EMCBE) held a conference entitled 'Sustainable Construction' in 2005 and this was repeated in 2006. A public/private partnership project is now underway, aiming to increase the sustainability of new development through design and construction within the region. The project comprises of a number of phases, including a regional architecture competition.

At a local level, some councils have been trying to increase energy efficiency in building design and construction. The Nottinghamshire local authorities have worked in partnership with the Newark and Sherwood Energy Agency and the Environment Agency to produce the Sustainable Developer Guide for Nottinghamshire. However, some authorities are doing better than others; Derby, Leicester and a handful of authorities in the south of the region have the lowest residential CO_2 emissions, but others are significantly higher, (see Figure 4.4).

There are a number of high profile sustainable living demonstration developments in the Region. The Sherwood Energy Village is designed to be a sustainable mixed use development on the site of a former colliery. Houses are built to high environmental specifications, reaching the Buildings Research Establishment (BRE) EcoHomes standard as a minimum (Newark and Sherwood District Council 2001). Designs include heat from ground source heat pumps and renewably powered lamp posts.

The other role of spatial planning in mitigating climate change is reducing the need to travel. The East Midlands RSS aims to facilitate non-car access to movement generating facilities, making it possible to walk and cycle or use public transport.

Figure 4.4 Map showing residential CO2 emissions per local authority area (Simmons and Gonzalez, 2006)



4.10 Leisure and Tourism

4.10.1 Importance of mitigation

Leisure and tourism is an important sector in the UK economy in terms of its contribution to GDP and a record number of visits to the UK in 2005 (ONS 2007). The main source of greenhouse gas emissions from the tourism sector is transport, both air and road. Tourist attractions generate significant amounts of movement, mostly by private car or air.

Tourism is also important to the economy of the East Midlands, contributing 3.5% to the Region's GDP in 2003 (Emda, 2003). The East Midlands has a number of tourist attractions, the Peak District National Park (PDNP) being the most significant in terms of visitor numbers.

4.10.2 Policy influence

National and regional policy supports the growth of tourism. It recognises the contribution tourism makes to the economy in terms of value added and employment provision and seeks to enhance this. There is also a recognition that tourism needs to be developed in a sustainable manner that protects the built and natural environment.

One of the most important considerations is encouraging tourists to access facilities using public transport; this is one of the Regional Tourism Strategy's Key Performance Indicators (KPI's). Providing non-car transport alternatives is a key priority of the Regional Tourism Strategy. There are already many examples in the region such as the Saunterbus in Northamptonshire and the network of bus

services to take people into and around the Peak District National Park, particularly at weekends and holidays. One objective is to support the growing demand for walking, cycling and riding thus minimising the environmental aspects of car parking in sensitive locations. It is also an objective to encourage seamless interchanges between different forms of transport, combination "day out" type tickets, and high quality information to make it easy for visitors to use public transport.

An example of sustainable tourism in the region is the design of a new eco-friendly youth hostel in the National Forest (Emda, 2006c). The youth hostel will incorporate elements of sustainable construction and operation such as the use of wood for the building, wood fuel and solar panels for heat and energy generation, water recycling and the use of recycled materials in construction. The Youth Hostel will be a "beacon of environmental good practice from which others can learn" (Clive Keble, National Forest Chief Officer Land and Project Development).

4.11 Public Health

4.11.1 Importance of mitigation

It is likely that climate change will impact on public health in the future, making it imperative that adaptation measures are taken in this sector. However, there are also opportunities for mitigation in the health sector, mainly because of the size of the NHS estate and workforce. The NHS is a huge energy consumer: total energy use is around 45 million GJ's per year (equivalent to supplying energy to about 525 thousand domestic homes a year), which is around one percent of the energy consumed by the whole of England (DoH, 2006).

Hospitals, surgeries and other NHS owned buildings are often old and energy inefficient and there is potentially massive emission reductions to be realised from them. Retrofitting of insulation, efficient heating and cooling systems and energy generation could reduce the carbon footprint of the health service significantly. There are 65 ambulance stations and 271 hospitals, surgeries and other NHS owned buildings in the East Midlands (DoH, 2006). This represents significant energy use and there is potential to increase efficiency. As many NHS sites have a considerable energy demand, there is also scope for installation of renewable energy or CHP plants.

The NHS is also Europe's biggest employer, thus having a role to play in influencing emissions from travel to and from work. Emissions reductions could be made by NHS staff choosing sustainable transport.

4.11.2 Policy Influence

The Department of Health have set two targets for the NHS (DoH, 2006):

- to achieve energy usage of between 35-55 GJ per 100 cubic metres for all new buildings (equivalent to up to one and a half times the energy usage of a domestic house) and 55-65 Gj/100 cubic metres for all existing buildings;
- to reduce primary energy consumption and reduce carbon emissions by 15 per cent from 2000 by 2010.

These targets have been set by the Minister for Health and are influenced by the Energy Performance of Buildings Directive (EPBD) and Building Regulations Part L. The targets will assist the NHS in reducing its carbon footprint significantly. Ten NHS Trusts from around the country have signed up to the Carbon Trust's NHS Carbon Management programme, designed specifically for each Trust and aimed at integrating good carbon management at all levels.

It is part of NHS Estate Strategy that all NHS Trusts are required to produce travel plans. Many individual NHS sites have also developed one. Travel plans are aimed at encouraging staff and patients to use sustainable modes of transport. An example in the East Midlands is the University Hospital of Leicester travel plan which focuses on staff initiatives such as cycle facilities, computerized car share facilities and negotiations with local public transport companies to provide extra services and fare discounts. It also considers car parking provision and charges as a means to encourage staff and visitors to use public transport.

There are opportunities to link mitigation strategies such as increasing the number of journeys made on foot or by bike with health initiatives. Promoting walking and cycling for their health benefits may encourage more people to switch to sustainable methods of transport. Reducing car traffic will also benefit those who suffer from respiratory diseases and other pollution related illnesses, improving quality of life for patients and saving the NHS money. A national initiative set up by the British Heart Foundation and Natural England, Walking the Way to Health aims to get more people walking in their own communities, especially those who take little exercise or live in areas of poor health. There is an East Midlands branch which organises walks throughout the Region and coordinates a network of walking clubs such as the Nottingham Best Foot Forward club and Oakham Healthy Walks.

4.12 Key Policies for Climate Change of Mitigation

There are a number of policies at the international and national scale that directly address the issue of climate change mitigation and many more that contribute indirectly. At a regional level, there is no East Midlands policy on climate change mitigation but the subject is addressed disparately through the various regional strategies. These climate change policies represent a number of threats and opportunities to stakeholders in all economic sectors in the East Midlands. Often, a single policy can represent both threats and opportunities within a sector. In general, traditional industries are threatened economically by mitigation policies whilst emerging industries stand to gain. The key impacts are summarized here.

The Region is heavily dependent on fossil fuel generated energy and electricity generation is a significant contributor to the regional economy. Policies at all scales threaten this part of the energy sector; the EU ETS, the RO, the Energy White Paper and the Regional Energy Strategy all represent additional costs for fossil fuel burning plants, reducing their competitiveness in the energy market. Possibly more significant is the policy ambition to reduce and potentially eliminate the market share of these traditional methods of electricity generation. Consequently, there are opportunities for new forms of energy generation that do not produce GHGs. Firms specializing in renewable energy generation stand to gain from the plethora of policies aimed at increasing the proportion of electricity generated from renewable sources. In addition, renewable energy policies offer economic opportunities to farmers and foresters who are willing to switch to growing energy crops.

Energy efficiency offers economic opportunities to all sectors. Heavy industry, manufacturers, service companies, householders and individuals can all benefit from reduced energy and water costs. The only stakeholders for whom energy efficiency could be seen as a threat are the energy manufacturers and suppliers.

Stakeholders in the transport sector face a similar pattern of threats and opportunities resulting from mitigation policies as those in the energy sector. The transport sector is an important contributor to the East Midlands economy. At a fundamental level, policy that aims to reduce car use threatens the automotive industry, one of the key manufacturing sectors in the East Midlands Businesses and individuals reliant on road transport will face higher costs as a result of road pricing, graduated Vehicle Excise Duty (VED) and parking charges. This may

threaten the manufacturing sector such as the food and drink and aggregates industry, which have traditionally been very important in the East Midlands economy. Distribution firms that have capitalized on the location of the East Midlands at the hub of many nationally important road networks specializing in freight and distribution may be hardest hit. Once again though, the economic threat faced by some stakeholders is mirrored by the opportunities presented to others. Other modes of transport including rail, water, public transport and cycling are likely to see an increase in patronage. This modal shift represents significant economic gains for firms operating trains, buses and shipping. There is also a link to the agriculture sector with the RFTO providing an incentive to grow more bio fuel crops.

In the building and planning sector there are more opportunities than threats as a result of mitigation policy. Home owners, tenants and housing associations stand to gain from policies that aim to increase the efficiency of buildings through lower energy and water charges and higher property values. In the short term, such policies may be seen as a threat by developers as energy efficient construction methods and materials are more expensive than those used traditionally although the price is likely to fall. The positive image created by engaging in sustainable construction may well be an opportunity for developers to exploit.

5 Adaptation

5.1 Introduction

While mitigation of climate change is essential to curb future impacts, uncontrolled anthropogenic emissions of GHG in the 20th century will cause climate change in coming decades that cannot be avoided. As such it is essential that the impacts of this change are analysed and adaptation practices identified.

This section identifies the current impact of weather on each sector and the potential impacts that climate change may cause. Also covered are the gaps in evidence for assessing climate impacts in the Region and the actions, at present, that have been undertaken to adapt to current and future climate change.

5.2 Water Resources

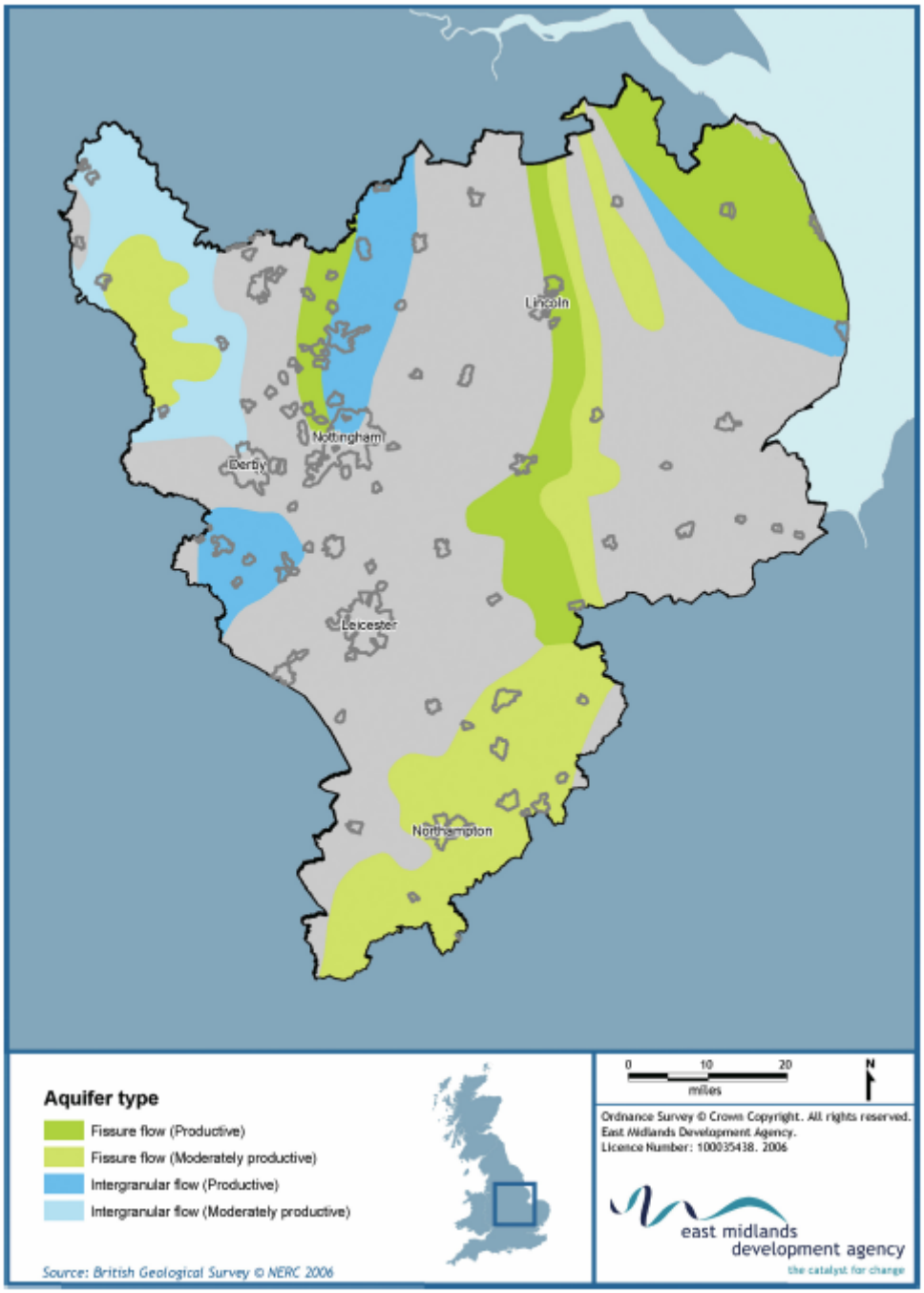
5.2.1 Importance of Sector

The East Midlands is one of the driest areas of the UK, receiving an average of less than 700mm of precipitation per annum, compared to an average of around 900mm for England and Wales (EA, 2007a). Rainfall is lowest in Lincolnshire and highest in the West of the Region – caused in part by the physical effect of the Pennines.

The greatest demand for water comes from public and industrial sectors, accounting for over 1150 and 350 Ml/d respectively; much of this water is treated and returned to the freshwater system (EA, 2007b). With around 400,000 new homes bring built by 2025, abstractions for domestic water supply could increase by up to 40% (Emda, 2006a). Direct abstraction by farmers for spray irrigation accounts for an average of 90 Ml/d, although at its height in the summer, demand can exceed that of public supply (ibid). Very little of this water is returned to the freshwater system and so the impact of these abstractions can be significant.

Water services in the East Midlands are provided by Anglian Water and Severn Trent. A large proportion of drinking water for the Region is sourced from surface water, including public supply reservoirs at Derwent Valley (Ladybower Reservoir), Rutland, Carsington, Ogston and Pitsford and the Rivers Trent and Derwent. Groundwater is also an important source of water for the East Midlands, with approximately 40% of the Region underlain by aquifers (see Figure 5.1) (Emda, 2006a). Many aquifers in the East Midlands are fully committed to existing abstractions, while surface water is also fully licensed in the summer months.

Figure 5.1 Location, and types, of major aquifers in the East Midlands (Emda, 2006a)



N.B. 'Intergranular flow' is the term for groundwater flowing through pore spaces, while 'fissure flow' refers to groundwater being transmitted, more rapidly, through fractures and fissures.

5.2.2 Current Weather-related Impacts

The Midlands last experienced a major drought in 1995-96. In spite of high winter rainfall in 1994-95, a combination of very low rainfall and very hot summer temperatures resulted in high water demand and very low groundwater, reservoir and river levels (EA, 2007c).

Cold temperatures during winter result in an increase in leakage from underground pipes as a result of freeze-thaw weathering damage.

5.2.3 Key Potential Impacts of Climate Change Identified

- Increased threat of drought on the Region's already fully-committed water sources. Demand for spray irrigation, for example, could increase by more than 20% (Downing et al., 2003).
- Increased risk of flooding causing contamination of, and disruption to, water distribution.
- Decreased freeze-thaw weathering damage to underground pipes, reducing losses to leakage.
- Increased winter rainfall providing opportunity for storage and groundwater recharge.
- Risk to the water quality of the Region's reservoirs from changes in temperature, solar radiation and threat of algal blooms.
- Increased risk of saline intrusion of freshwater aquifers.
- Higher soil moisture deficit in summer and autumn delaying winter recharge.
- Increased evaporation reducing quality and quantity of water in open storage.

5.2.4 Gaps in Evidence

The key gap in this sector is the lack of research into the impact of climate change on water infrastructure and assets.

5.2.5 Adaptation to Current and Future Impacts

The Environment Agency has produced a 'Water Resources Strategy for the East Midlands', which adopts a similar scenario approach to that used by UKCIP and incorporates the impacts of climate change using UKCIP98 (Waters, 2004). The strategy looks at how supply and demand can be managed up to 2025 and has been carried forward into Catchment Abstraction Management Strategies (CAMS) for the Region.

Water companies are required to produce drought plans in conjunction with the EA and are set targets for reducing leakage and improving headroom levels by Ofwat (the regulator for water in England and Wales), thus ensuring they are giving due consideration to water supply in the future.

In a bid to alleviate stressed aquifers and combat the future effects of climate change, water companies are reducing groundwater licences; already 58% of catchments are closed to further summer abstraction (Defra, 2005a). In response, some farmers have developed winter storage for their own use (ibid).

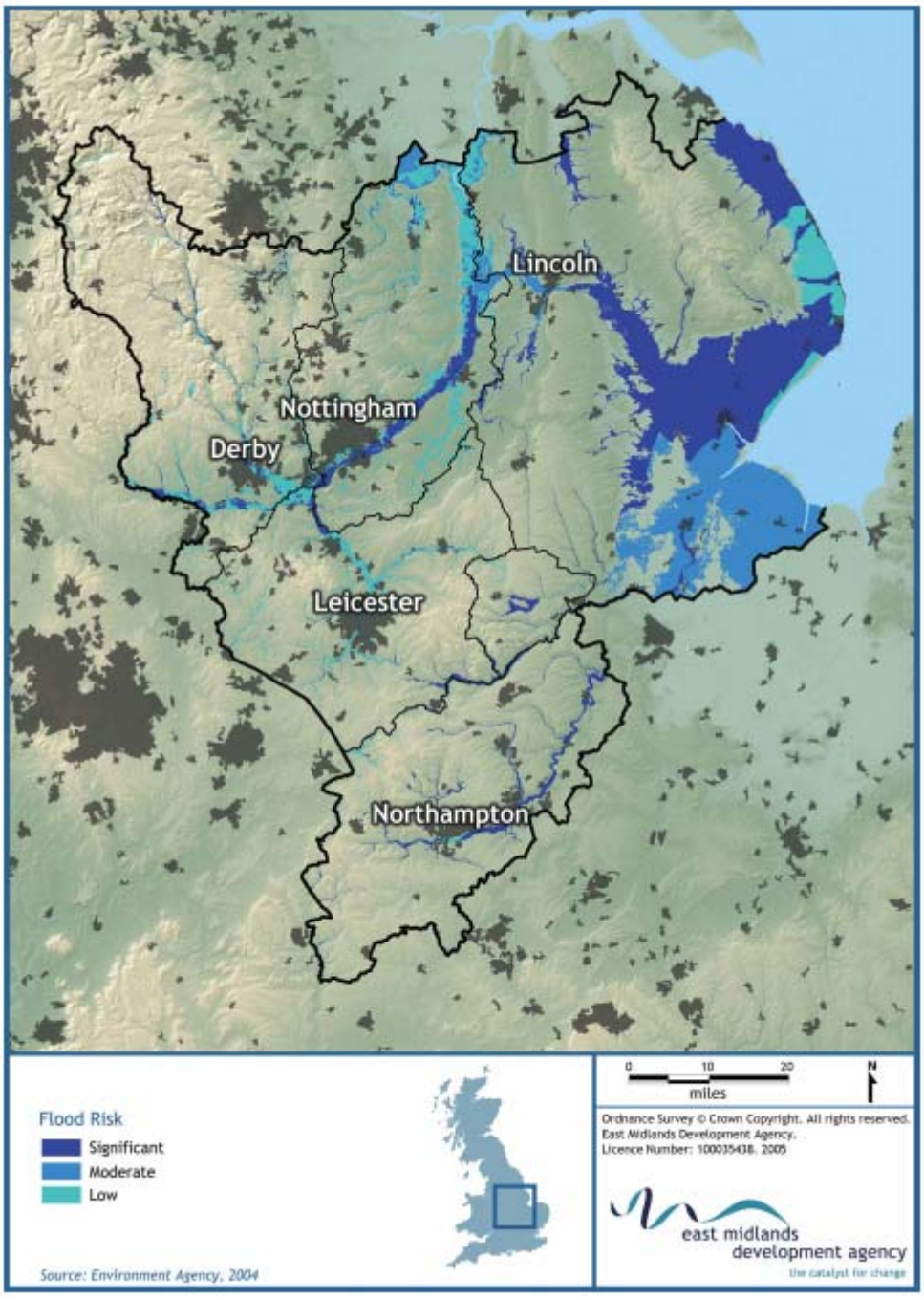
5.3 Flood Management

5.3.1 Importance of Sector

Approximately 17% of land, 350,000 people and 143,000 homes in the East Midlands are at risk from flooding (see Figure 5.2) (Emda, 2006a). The Region is protected by flood defences for much of the coast and major river channels; the standards of flood protection provided by these defences are generally high, but do not reach desired target standards in every location (Faber Maunsell, 2006).

Over half of the best quality agricultural land in the Region is less than 5 metres above sea level (Emda, 2006a). An area of 1460km2 is protected from tidal flooding which, without flood defences, would be regularly inundated. Elsewhere flood risk is high on the floodplains of all the major rivers in the East Midlands; the Trent, Derwent, Soar, Nene and Witham. In total 15% of the Region is at risk from 1 in 100 year floods.

Figure 5.2 Flood risk in the East Midlands (non-managed) (Emda, 2006a)



5.3.2 Current Weather-related Impacts

Flooding in April 1998 affected the Nene, Ise, Soar, Wreake and Smith catchments, caused by extended periods of moderate rainfall, rather than short periods of extreme storms. The Trent catchment also experienced serious flooding

in the winter of 2000, resulting in the flooding of over 600 properties and an estimated £20 million of damage (Waters, 2004).

While recent sea level rise may appear insignificant at 1mm per year, average wave heights increased by 15% between the 1980s and 1990s (Waters, 2004).

5.3.3 Key Potential Impacts of Climate Change Identified

- More extreme rainfall events increasing the risk of pluvial flooding (e.g. Birmingham drainage system may be overwhelmed), and also fluvial flooding (e.g. on major rivers such as the Severn).
- Increased risk of coastal flooding from rising sea-levels, increased wave heights and larger storm surges
- Drier summers may delay the onset of the flood season
- Birmingham drainage system may be overwhelmed
- Flood defences are designed and built to protect against a particular return rate of flood (e.g. 1 in 100 years). The onset of climate change may cause the return frequencies of flooding events to shift, i.e. what was a 1 in 100 year event may become as frequent as a 1 in 50 year flood. In some areas defences for a 1 in 100 year flooding event were breached and replacements have been planned for 1 in 200 year floods.

5.3.4 Gaps in Evidence

Predictions for the impact of climate change on the frequency and severity of storm surges involve many variables including sea level rise, wave heights and storminess. While Defra have factors in place for including climate change impacts into the design of flood defences, a key gap is the provision for factors on a regional level. This includes fluvial flooding and the inclusion of climate change into all types of flood risk assessment.

5.3.5 Adaptation to Current and Future Impacts

A new planning guide for developers 'Planning Policy Statement 25: Development and Flood Risk' provides advice on how to assess implications for flooding of new developments; the developers themselves are now responsible for flood risk assessment rather than the planning authority. The planning guide also stipulates that discharge from any new development may not be more than if the site remained as Greenfield. Also recommended is the use of Sustainable Urban Drainage Systems (SUDS), which includes suggestions to encourage more interception of water at household level.

Anglian Water has implemented a scheme whereby, in return for cheaper water rates, households are encouraged to disconnect roof drainage from the sewer system. New sewers installed by Severn Trent Water are now designed to standard with an allowance for climate change (Waters, 2004).

The Lincshore programme of renourishment to protect 24 km of Lincolnshire coast finished its first stage in 1998 at a cost of £50 million (M4I, 2000). This is an ongoing project designed to prevent the sea defences from diminishing, at the same time providing an attractive beach for visitors.

Currently the EA makes an allowance of 6mm per year for sea level rise when planning coastal defences (Waters, 2004).

In February 2006, the East Midlands Regional Assembly (Emra) commissioned Faber Maunsell to undertake a Regional Flood Risk Appraisal (RFRA) to form part of their Regional Spatial Strategy (RSS). This report, published in July 2006, summarises the flood defences of the sub-areas of the Region, identifying which

areas have had a Strategic Flood Risk Assessment (SFRA) and which areas are most at risk. The report identifies coastal Lincolnshire, Newark & Sherwood and Nottingham as examples of areas with high inherent flood risk; however many such areas have undertaken SFRAs and have therefore considered these risks (Faber Maunsell, 2006). The Local Planning Authorities (LPAs), who are responsible for carrying out the SFRAs, are advised to take climate change into account when assessing flood risks.

5.4 Biodiversity and Conservation

5.4.1 Importance of Sector

As agriculture has intensified and land use has changed, biodiversity has declined more quickly in the East Midlands than in any other region in England; with widespread loss of woodlands, hedges, heathlands, wetlands and species-rich grasslands. Agricultural intensification in the Region during the 20th century saw wetlands drained, grasslands ploughed, hedgerows removed and increased use of herbicides and fertilizers in the drive for expansion and efficiency (Emra, 2006a).

The Region contains important conservation areas such as the Peak District National Park, Rutland Water, Sherwood Forest, Lincolnshire Limewood, the Lincolnshire coast and the Wash (see Figure 5.3). However, excluding Derbyshire, only 2% of the region is designated as a Site of Special Scientific Interest (SSSI) compared to a national average of 7%. In March 2006, almost 40% of the SSSIs in the Region were classified as 'unfavourable declining', 'unfavourable – no change', 'part destroyed' or 'destroyed' (Emda, 2006a).

Species of international importance found in the Region include: spined loach, gadwall, great crest newt and the Natterjack toad. However the Region has lost up to 85% of its farmland birds within 25 years, and 70% of scarce plant species in Leicestershire, Northamptonshire and Nottinghamshire since 1970 (Entec, 2000). Much of this loss is caused by management of farmland; grasslands have been ploughed or improved, 88% of the heathland in Lincolnshire has been lost since 1925 and the wetlands of the Lincolnshire fen have been drained (ibid).

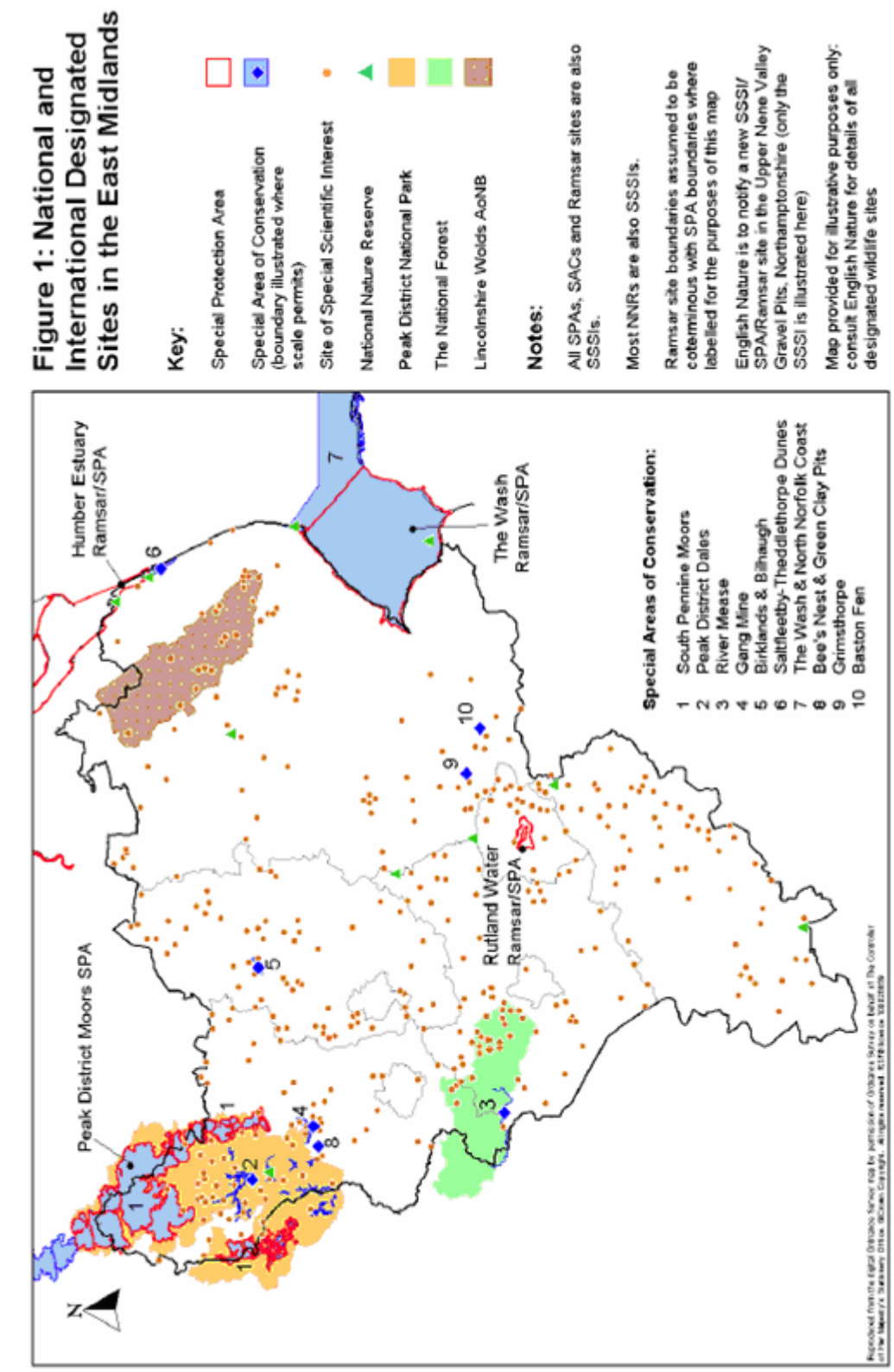
The EA have identified several key water-based species as 'priority species' for protection in the East Midlands, these include: European otter, Burbot, Freshwater white-clawed crayfish, Derbyshire feather-moss and Greater-water parsnip (EA, 2007d).

5.4.2 Current Weather-related Impacts

Rather than impacts on biodiversity from weather, the sector has already been affected by changing climate. Warmer winter temperatures have affected many bird species; including changes to migratory and breeding patterns (breeding earlier, laying larger clutches and raising more young) and increased winter survival rates of resident species (e.g. blue and great tit) (Hossell et al., 2000).

Other changes include changes in timing of plant life cycles, increased winter survival rates for invertebrates (e.g. for aphids) and changing species distribution (Hossell et al., 2000).

Figure 5.3 National and International Designated Sites in the East Midlands (Emra, 2006a)



5.4.3 Key Potential Impacts of Climate Change Identified

- Loss of habitat on the Lincolnshire coast from sea-level rise and erosion.
- Low river flows reducing aquatic habitats; lower water table limiting wetland habitats.
- Southern species may be forced to move further North, such as the lesser horseshoe bat, butterflies.
- The invasive grass species Brachypodium pinnatum, currently at its northern limit in Derbyshire, may spread throughout the Peak District with warmer temperatures; Brachypodium is a serious threat to biodiversity (Buckland et al., 2001).
- Loss of plants such as Jacob's Ladder (Polemonium caeruleum), of which the Peak District contains nearly all colonies. They can only survive on north-facing slopes in the Peak and will not survive in warmer, drier conditions.
- Increased risk of moorland fires in the Peak District, which could result in the replacement of heather moorland by brass, with serious implications for soil erosion and grouse-shooting.
- Threat to wetlands from water abstraction and hotter, drier summers; this will also threaten the habitat of ducks, geese and waders native in the Region. However, this maybe offset by wetter winters.
- New species may occur in the East Midlands.
- Disturbance to bird migration patterns from warmer winters
- Decrease in soil moisture content
- Loss of flora species
- Changes in invertebrate population growth rates, predator/prey relationships and interactions between species
- Southerly-distributed amphibians may benefit from warmer and wetter conditions, such as the natterjack toad.
- Increased winter survival rates for mammals
- Disruption to hibernation patterns

5.4.4 Gaps in Evidence

There appears to be a large amount of research commentating on the loss of biodiversity in the Region and those species that are at risk, yet there is no evidence of how this threat has been translated into policy.

There is little research that is specific to the impacts of climate change to species in the East Midlands.

There is no consensus on the impact of climate change on the peat bogs in the Peak District. While wetter winters will benefit them, the hotter and drier summers result in fungal and bacterial decomposition, which release carbon.

5.4.5 Adaptation to Current and Future Impacts

The Regional Environment Strategy targets a rise to 7% of the Region to qualify as an SSSI, bringing the East Midlands up to the national average (Emra, 2002).

Emra, in conjunction with East Midlands Biodiversity Forum (EABF), published a biodiversity strategy for the Region in May 2006. This report details a strategy for protecting and encouraging the wildlife in the area. The report identifies key Biodiversity Conservation Areas (BCAs) and Biodiversity Enhancement Areas (BEAs) in the Region, which are important for recovering biodiversity to sustainable levels (Emra, 2006).

5.5 Agriculture, Horticulture and Forestry

5.5.1 Importance of Sector

Agriculture covers over 1.2 millions hectares in the East Midlands, accounting for approximately 77% of land use (Defra, 2004). The Region is home to around 20,000 farms, employing over 41,000 people on a full or part time basis (ibid). With the proportion of high quality, versatile agricultural land (grades 1, 2 and 3a) at 47%, the Region is above the national average of 39% (Emda, 2006a). Much of the Region's high quality agricultural land is found in Lincolnshire; however this is also the driest area of the East Midlands and so requires a large amount of irrigation to support the land.

The 1,895 holdings for horticulture account for 41,300 hectares of agricultural land in the East Midlands; however, since 1990, the industry has seen a 51.9% and 6.9% reduction in number of holdings and hectares of land respectively (Defra, 2004).

The East Midlands is the least wooded region in the country with an average of 4.8% coverage compared to a national average of 8% (Space4trees, 2005). While timber production is not a key industry in the Region, woodlands are managed for both timber and recreational activities.

5.5.2 Current Weather-related Impacts

Warmer, drier summers have increased the length of the growing season and provide favourable conditions for crops such as cereals; however, the effect of anomalously hot weather varies depending on the crop. During the hot weather in the UK in 1995, for example, major crops in the UK (e.g. wheat, barley, oilseed rape) fared well, whereas potato and other vegetable crops suffered losses (Palutikof et al., undated). The impact of the 1995 drought was a gain of around £29 million to arable crops, but a loss of over £200 million for the livestock industry, leaving a net loss of approximately £170 million for the country (ibid). The heat wave in Northern Europe in 2003 caused, on average, a 20% reduction in yield across Northern Europe (BBC, 2005).

A shortage of grazing pasture was experienced during the summer droughts of 1976 and 1995, forcing an increase in the price of fodder.

The increase in growing season also has had an impact on forestry, with spring leaf unfolding 6 days earlier and autumn colouring delayed by 4.8 days, resulting in increased biomass formation and tree growth.

Current weather effects on horticulture are minimal as most producers in the East Midlands grow under glass; however there are small benefits from warmer winter temperatures resulting in lower heating requirements.

5.5.3 Key Potential Impacts of Climate Change Identified

- Opportunity to grow crops not previously suited to the Region's climate
- Warmer temperatures may bring new pests and diseases to the Region

- Longer growing season resulting in higher crops yields and availability of locally grown produce throughout the year
- Lower crop prices caused by increased yields
- Increased demand for water for irrigation, particularly in horticulture, fruits, vegetables and cereals.
- Loss of soil moisture and increase in soil erosion; particularly at risk are arable crops such as maize and oil seed rape, which are grown in the Region.
- Reduced vernalisation (cold weather required by some crops, including winter cereals, for flowering
- Loss of yield in some crops (e.g. potatoes and vine peas)
- More refrigerated distribution and storage required; problems with livestock transportation in high temperatures.
- Increased risk to forest of drought, fire and abundance of disease and pests
- Increased water logging leading to reduced stability in trees and fine root death
- Reduced energy demand for space heating in winter for horticulture
- Loss of agricultural land on floodplains and coastal areas
- Shortage of lowlands grasslands in mid-summer for grazing
- Reduction of need for protection of livestock from cold in winter, but increased requirement for shade in summer months.

5.5.4 Gaps in Evidence

The REGional climate change Impact response Studies (REGIS) project analysed yields of a variety of crops under various climate change scenarios for North West England and East Anglia; incorporating, among other factors, the changes in temperature and water availability. The East Midlands would benefit from a similar study, helping to predict which crops will be best suited to changing conditions.

Agriculture is made up of many individual businesses; therefore there is difficulty in encouraging changes in a coherent and cost-effective manner.

Water efficient irrigation techniques such as drip and bubble irrigation account for just 5% of irrigation techniques in the UK; while rain water and re-used water account for just 1.6% and 0.5% of irrigation water respectively (Downing et al., 2003). There is no data on how much water would be saved in the Region is these percentages were increased, and the costs involved.

As summers become hotter, the need for shade for livestock increases, there has been no study of how climate change will affect farm animals and the requirement for shade. A dairy Cow, for example, has a thermoneutral (comfort) zone of approximately -5°C to 25°C, above this upper limit the animal struggles to cool itself – cows only sweat at 10% of the human level (Defra, 2002). Among other adverse effects, heat stress causes the reduction in quality and quantity of milk, reduction in fertility rates and an increase in calf mortality during pregnancy (ibid).

5.5.5 Adaptation to Current and Future Impacts

The Environment Agency and National Farmer's Union have produced a 'Good Farming. Better Environment' report, which includes a section on climate change (Environment Agency, 2006). The report describes actions that have already

begun, such as trying alternative crops, water efficiency methods and changing soil and crop management to mitigate flood risk. However, this report is generic for the whole of the UK and does not detail any region specific practices.

5.6 Energy

5.6.1 Importance of Sector

The East Midlands is in close proximity to fossil fuels, cooling water and the electricity distribution network; as a result the Region has an above average concentration of power generation and is a major exporter of electricity.

Energy production in the East Midlands is reliant primarily on coal, with the remaining five coal-fired power stations in the Region accounting for 10–15% of the UK's generating capacity (Emra, 2002). Another major source of energy in the East Midlands is coal mine methane, which is extracted from disused coal mines, the largest example of which is the 9MW plant at Shirebrook, supplying around 10,000 homes (ibid). Renewable sources of energy in the Region, largely from landfill gas, account for just 1.6% (44.1 MW) of consumption (ibid).

The East Midlands accounts for 6.4% of the UK's total energy consumption (DTI, 2003). This consumption is predicted to increase by 20% over the next 25 years. In the power sector, increased demand for oil and gas is not completely offset by a reduction in demand for coal, such that a 6% increase in overall energy demand is predicted by 2025 (Emra, 2001).

5.6.2 Current Weather-related Impacts

A study by Subak et al. (2000) of the economic effects of the anomalously warm year of 1995 on the UK showed significant correlation between energy use for domestic heating and temperature, particularly for gas (as the predominant fuel for heating) and the winter months. The energy saving to the consumer of the 1994/95 mild winter is estimated to be £355 million.

In the hot summer there was an added domestic electricity cost of £34 million, but this was more than offset by a reduction of £74 million on domestic gas consumption (CRU, 1995)

Some evidence suggests that hotter summers result in a higher electricity demand from increased refrigeration and air cooling, but at present, this is not substantial compared to the reduction of energy use in mild winters (Palutikof, undated).

5.6.3 Key Potential Impacts of Climate Change Identified

- Reduced winter space heating demand; this is significant as around 85% of domestic energy use in the UK is for space and water heating (Met Office, 2006).
- Increased summer electricity demand for refrigeration and air cooling
- Damage to power lines from high winds and storms, but reduced damage by ice and freezing conditions
- Heightened risk of subsidence and heave leaving structures vulnerable to damage or collapse
- Power stations restrained by water availability

5.6.4 Gaps in Evidence

There is a lack of evidence on the Impact of future climate change on existing and future energy generation assets. Such research should include standards and

guidelines for the design and construction of energy infrastructure under increasingly extreme weather.

5.6.5 Adaptation to Current and Future Impacts

To date, policies related to energy and climate change are predominantly concerned with mitigation rather than adaptation. The 'Viewpoint on Sustainable Energy' commissioned by the Emra recommends an energy reduction target per household of 20% by 2012 and a further 20% by 2020 (Waters, 2004). This would reduce reliance on energy and the national grid.

5.7 Transport

5.7.1 Importance of Sector

The East Midlands provides important road, rail and air links for the UK. Key north-south road routes such as the M1 and A1, and east-west routes such as the M69 and A14, pass through the Region. The East Midlands airport serves, behind Heathrow, as the second largest UK airport for freight (Emda, 2006b).

Rail networks include the Midland Main Line and the East Coast Main line, which run from London King's Cross. The proposed extension to the Channel Tunnel Rain Link to St. Pancras station will make mainland Europe more accessible to the East Midlands as St. Pancras is adjacent to King's Cross station.

5.7.2 Current Weather-related Impacts

The impact of weather on transport is immediate but varied; the incidence of road traffic accidents (RTAs) increases where there is loss of visibility and/or loss of vehicular control (Edwards, 1999). While the majority of RTAs occur in fine weather (being the most common weather condition), rainfall is the second most likely weather condition for RTAs, accounting for at least 11% of accidents per month all year round (ibid). Other hazardous weather conditions such as fog, high winds and snow appear to cause fewer accidents in comparison to rain, yet such conditions may actually cause fewer journeys to be attempted (ibid).

Hot temperatures bring speed restrictions for railways and an increase in cycle accidents as more cyclists are on the road. While high temperatures can also cause bitumen in road surfaces to become viscous; crushed rock dust can be spread to reduce damage to road surfaces and reduce the risk of accidents. Foggy conditions can cause delays on flights in and out of Nottingham East Midlands Airport as seen in December 2006.

Pluvial and fluvial flooding can cause widespread damage and disruption to transport. Flooded roads can cut off travel routes, especially in rural areas where there may be no alternative roads. As well as affecting virtually all modes of transport, there is also a significant risk to the safety of drivers and passengers.

5.7.3 Key Potential Impacts of Climate Change Identified

- Increased summer air temperatures causing extreme temperatures on public transport
- Increase in frequency of enforced speed restrictions on railways in high summer temperatures
- Danger to overhead railway cables caused by increase storminess
- Increased disruption to road and rail transport cause by increased storminess

- Risks to roads and railways from increased risk of winter flooding and summer subsidence
- Warmer temperatures allow the opportunity to encourage walking and cycling
- Change in fall of autumn leaves disrupting railways
- Decreased need for grit roads and runways caused by icy conditions, but increased need to dust roads in hot summer weather.
- Increased rail safety and maintenance requirements

5.7.4 Gaps in Evidence

There have been no Investigations into current peak air temperatures on public transport in the East Midlands and how they can be expected to change. There is a requirement for a better understanding of large scale transport disruption by extreme weather events, and which measures to mitigate such disruptions have proved successful in other areas of the UK.

There has been no flood risk assessment of transport infrastructure in the Region. It is essential to know whether roads and railways will cope with more extreme rainfall and that those at risk from fluvial flooding are adequately protected.

5.7.5 Adaptation to Current and Future Impacts

No action to date.

5.8 Manufacturing, Industry and Services

5.8.1 Importance of Sector

The East Midlands has a larger manufacturing industry than the UK average with a concentration of traditional manufacturing sectors. Many are declining industries; including mining, fuel processing, metals, minerals, transport equipment and textiles. These traditional industries tend to be energy intensive and account for 35.4% of the East Midlands' energy consumption. The Region is under-represented in such growth sectors as communications, finance, business services, property and electronic engineering.

The largest contributor to the area's output is manufacturing, which produces 22% of the Region's output (Alliance Trust, 2006). This is followed by real estate, renting and business services, which account for 20%, and retail and wholesale, which account for a further 14% (ibid). Exports from the Region account for 8% of all UK exports, with manufacturing and transport exports forming the bulk of exports at 71% (ibid).

In 2005, 2 million people were employed in the East Midlands, with 76%, 17% and 5% in the sectors of services, manufacturing and construction respectively (ibid).

5.8.2 Current Weather-related Impacts

Manufacturing industries that are not directly reliant on natural resources are not generally affected by weather, unless through loss of infrastructure from extreme winds or flooding or from delayed delivery and collection of materials.

Industry which requires large amounts of water is at risk from drought. Mansfield brewery, for example, has been forced to use top-up tap water to supplement the water it extracts from two boreholes from the Sherwood aquifer.

A study by Agnew & Palutikof (1999) of the climate and retailing showed strong correlation between the industry and winter and spring temperatures. However, it

was also noted that clothing sales in the UK suffered in the very hot summer of 1995, whereas food and drink sales (especially alcohol and, to a lesser extent, fresh fruit and vegetables) increased with temperature.

There are four types of extreme weather that give rise to domestic insurance claims; hot dry summers (subsidence), strong winds (structural damage), freezing temperatures (burst pipes) and river flooding (structural damage). Storms (primarily) and floods (secondary) contributed to over 90% of the total costs of weather-related natural catastrophes classified by re-insurers as 'significant' between 1970 and 2004 (ABI, 2005).

In the past five years, over 300,000 small and medium-sized enterprises (SMEs) have been affected by flooding, costing them approximately £864 million in damages (Metcalf and Jenkinson, 2005). Proportionally, those areas more likely to suffer from flooding include the East Midlands, as well as Scotland, East Anglia and Wales (ibid).

5.8.3 Key Potential Impacts of Climate Change Identified

- Damage to infrastructure from high winds and storms
- Increased flooding risk leading to damage to stock and premises and insurance problems
- Boost in sales of seasonal goods (e.g. water retention products, food and drink)
- Delays to transport in goods from adverse weather conditions
- Increased costs of insurance
- Adverse impact of high summer temperatures on working conditions in offices and factories.
- Vulnerability of 'just-in-time' delivery systems to disruption in transport.

5.8.4 Gaps in Evidence

Little research has been conducted for adaptation to climate change in manufacturing. There has been some investigation in the service and insurance industries, but this has not been specific to the East Midlands. The joint UKCIP and acclimatise project, for example, analysed various business sectors for their vulnerability to climate change and involved questioning businesses as to their attitude to climate change and how it has affected them thus far (Firth and Colley, 2006).

5.8.5 Adaptation to Current and Future Impacts

Large industry in the Region appears well protected from flooding, the drainage system at the Toyota plant in Derby, for example, has been designed to cope with a 1 in 500 year rainfall event.

Some manufacturing companies that use water for cooling, such as Glynwedd in Derby, have developed closed-loop systems on site leaving them less vulnerable to water shortage.

Little adaptation action has been undertaken for the manufacturing and service industries, as the current emphasis is on mitigation of carbon dioxide and efficiency in business; this includes reaction to the Climate Change Levy, most of which has been negative (Waters, 2004).

5.9 Built Environment and Planning

5.9.1 Importance of Sector

There are 1.8 million households in the East Midlands, an increase in 10% over the last ten years (Alliance Trust, 2006). Estimations by Entec in the 2000 technical report state that the East Midlands will require approximately 363,000 new homes by 2021. Recent proposals for housing development have included plans for greenbelt land surrounding Nottingham, some of which have been approved; others have been rejected after much local opposition (Rushcliffe Council, 2006 and BBC, 2006). However, there appears to be a continued issue of housing requirement and suitable land for development.

5.9.2 Current Weather-related Impacts

Weather impacts working conditions in construction, with particularly high temperatures and concentration of sunlight causing problems with working with concrete and cement as well as increasing the health risk as sites are dustier and chemicals more volatile at high temperatures.

During the hot summer of 1995 in the UK, damaged caused by subsidence resulted in losses of £326 million for the insurance industry (Defra, 2006).

The frequency of wind damage to buildings rises logarithmically with wind speed; therefore a 5 m/s increase in wind speed would be associated with a fivefold increase in the number of damage incidents (Baxter et al., 1999).

Buildings and infrastructure are usually the most seriously affected sector when flooding occurs. Of the 25 million homes in England and Wales, the Environment Agency estimates that 2.3 million are at risk from flooding, amounting to £237 billion of property, land and assets (Osborne, 2006).

5.9.3 Key Potential Impacts of Climate Change Identified

- Increased risk of flooding and damp for buildings
- High summer temperatures and sunlight exposure causing problems for working conditions in construction
- Increased risk of subsidence
- Wetter winters causing delays for construction work
- Reduced condensation and deterioration in drier summers
- Reduced winter energy demand for space heating
- Reduced frost damage
- Increased mould growth

5.9.4 Gaps in Evidence

There is a lack of guidelines on incorporating the impacts of future climate change into planning of infrastructure. Another important gap is while there are checklists for inclusion of climate change into housing design and construction, such as the checklist for development produced by the Three Regions Climate Change Group (reference), there is a lack of policy implementation to make them a requirement.

5.9.5 Adaptation to Current and Future Impacts

Higher wind speeds are already included in existing building design (Entec, 2000).

No specific response to climate change has been identified, although energy conservation has been integrated in some developments. New build housing funded by the Single Regional Housing Pot is now required to meet the 'good' standard as set by EcoHomes, the residential version of BREEAM (British Research Establishment Environment Assessment Method) (Emra, 2006b).

The Regional Flood Risk Appraisal commissioned by Emra included details of which sub-areas of the Region have plans to build on Zone 3 (the high-risk zone as designated by the EA). These include Boston, East Lindsey, Lincoln, West Lindsey, Chesterfield, Nottingham and some areas of Leicester and Leicestershire.

5.10 Leisure and Tourism

5.10.1 Importance of Sector

Tourism is very important in the East Midlands, particularly with the Peak District National Park (PDNP). Visitors to the PDNP are estimated to spend around £450 million a year in the wider Peak area, supporting over 14,000 jobs (PDNP, undated). Other important areas include the Lincolnshire coast, Rutland Water, Lincoln Cathedral and sporting venues such as Trent Bridge cricket ground, Silverstone and Donnington racing circuits and several large football stadia. Tourism in the Region employs over 200,000 people in approximately 30,000 businesses and accounts for 3.5% of the GDP (Emda, 2003).

In 2002, the East Midlands was visited by approximately 11 million domestic tourists and 825,000 foreign visitors (Emda, 2006a). The East Midlands also has 455 miles of navigable waterways which attracted 10 million visitors in 1998.

5.10.2 Current Weather-related Impacts

Currently there is no evidence to suggest that warmer, drier summers increase the number of tourists in the UK and while it can be expected that warmer weather may promote a more outdoors lifestyle, there is the danger that substantially higher temperatures may have a detrimental effect on tourism by encouraging people to stay inside and out of the heat. However, leisure and tourism activities are affected by more local weather conditions, with spells of hot dry weather resulting in large visitor numbers to UK beaches.

5.10.3 Key Potential Impacts of Climate Change Identified

- More year-round sporting and tourism opportunities
- Damage to conservation areas, such as the PDNP, with larger visitor numbers
- Loss of heritage sites to sea-level rise and erosion on Lincolnshire coast
- Increased domestic and international tourism
- Loss of Lincolnshire beaches to coastal flooding and erosion
- More reliable favourable weather in the summer benefiting tourism and visitor numbers.
- More walking and cycling for leisure and work

5.10.4 Gaps in Evidence

In 2003 Emda published the East Midlands Regional Tourism Strategy 2003-2010, setting out the strategy for encouraging tourists to the Region and improving the

industry. While this report describes some environmental concerns with tourism, there is no mention of climate change and the impacts it will have.

There is a lack of data regarding levels of access to the countryside for those living in and around the Region, as well as estimations of future visitor numbers to key attractions, such as the PDNP, and what impact this will have on them.

5.10.5 Adaptation to Current and Future Impacts

No action to date.

5.11 Public Health

5.11.1 Importance of Sector

The quality of public health is both the source of, and the product of, economic success. A healthy population is essential for the development of the Region. Public health is closely linked to the climatic conditions of the Region and is therefore of significant importance in the study of climate change impacts.

5.11.2 Current Weather-related Impacts

In the UK, heat-related deaths occur when mean daily temperatures (the average temperature, out of direct sunlight, in a 24 hour period) are greater than 15.6-18.6°C (Donaldson et al., 1999). In the UK at present, extreme temperatures cause approximately 800 deaths and 80,000 days of NHS hospital treatment per year (ibid). During the heat wave of the summer of 2003 the East Midlands experienced a minimum maximum temperature of 23.1°C and a maximum temperature of 35.5°C (Johnson et al., 2005). Deaths associated with the heat wave caused an increase of 17% for all ages and 21% for over 75s in the Region (ibid).

High summer temperatures are also associated with high levels of ozone and particulates in the atmosphere, which can irritate lungs and trigger asthma attacks. An episode of high daily concentrations for a two week period in 1976 led to an increase in mortality by 9.7% in England and Wales (Andersen et al., 1999).

Food poisoning is associated with warmer weather and so increased average temperatures are predicted to be accompanied by increases in food poisoning cases (Bentham, 2001). Salmonella, for example, will replicate when ambient temperatures are warmer that 7°C and reach an optimum at 37°C (ibid).

There has been an increase in incidence of Lyme disease spread by ticks as a result of milder winters. However, tick abundance and distribution is primarily affected by land use rather than climate.

The UK has one of the highest rates of cold-related deaths in Europe, with an estimated 20,000-50,000 excess in number of deaths in the four months December to March (Donaldson et al., 1999).

5.11.3 Key Potential Impacts of Climate Change Identified

- Fewer cold-related deaths
- Increased heat-related deaths
- Increase in food poisoning cases in warmer temperatures
- Small risk of the return of indigenous malaria to the Region
- Warmer temperature may provide suitable climate and habitat for new pests and diseases

- Increased flooding causing loss of life, injury and loss of hygienic services (food, water sanitation)
- Decrease in air quality in hot, sunny summers leading to increase in breathing problems and asthma attacks
- An increase in skin cancer and eye damage cases from exposure to UV radiation
- Psychological problems caused by severe flooding events

5.11.4 Gaps in Evidence

The Emra Public Health Strategy published in 2003 does not address the issues of public health and climate change. As this was written before the heat-wave in Northern Europe, it does not address ways in which heat related deaths could be prevented. This will become an increasingly important issue.

5.11.5 Adaptation to Current and Future Impacts

No action to date.

5.12 Key Impacts for Climate Change Adaptation

While climate change will have an impact on all sectors of the East Midlands, some impacts will be more substantial than others, and hence will require more consideration and action for adaptation. Perhaps the most important feature of climate change for the Region is the impact on water; both as a resource and the threat of flooding. Precipitation under climate change is predicted to decrease in summer months and increase during the winter. The East Midlands is one of the driest areas of the country and with the entire Region's water resources currently fully committed, there is a vulnerability to drought; while more frequent extreme rainfall events in the winter leave the Region at risk from both pluvial and fluvial flooding.

The threat of drought is also a substantial threat to agriculture in the Region; a sector which accounts for 77% of land use in the East Midlands. Climate change will provide the opportunity for new, and more varied, crops to be grown; however, warmer temperatures will increase the demand for irrigation in summer months and add to the strain on a diminishing resource.

Biodiversity and conservation have been in severe decline in the East Midlands in recent years; climate change provides both an opportunity and a threat to the sector's improvement. While the Region does have a lower than average concentration of SSSI sites, it is home to the Peak District National Park a substantial habitat for many of the Region's species. Climate change will have both positive and negative effects, depending on species, however they must be well monitored and managed to ensure the sector is does not decline further.

Tourism is a key industry in the East Midlands, accounting for over 200,000 employed people and bringing visitors to such attractions as the PDNP, Lincolnshire coast, Rutland Water and the many sporting venues. Warmer temperatures brought about by climate change may attract more visitors to the Region in preference to overseas resorts that may become too hot. This provides both the opportunity of bringing more spending customers in to the Region, whilst at the same time increasing the threat from larger visitor numbers to protected areas such as the PDNP. There is also a threat to key heritage sites from sea-level rise and erosion on the Lincolnshire coast, as well as to the beaches themselves.

The impact on the Region's health will be varied under climate change; while there is predicted to be an increase in heat-related deaths in the summer months (such

as those seen in 2003), this is expected to be outweighed by the reduction of cold-related deaths, as a result of milder winters. Other significant threats come from the increased risk of food-poisoning cases in the hotter summers, a deterioration of air quality on hot summer days and an increase in cases of psychological problems caused by major flooding events.

6 Mapping and Prioritisation

6.1 Introduction

This chapter describes the process of integrating the policy priorities identified in Chapter 2, with the key mitigation and adaptation impacts and opportunities identified in Chapters 4 and 5, and the subsequent selection of case studies. This process was carried out in three stages:

- Stage 1 – Mapping the impacts and opportunities of climate change mitigation and adaptation onto the RES priority actions.
- Stage 2 – Setting the key policy priorities against key climate change impacts and opportunities.
- Stage 3 – Identification of potential case studies.

6.2 Stage 1

As a preliminary stage all the RES priority actions were considered with respect to any potential impact and opportunity associated with climate change mitigation and adaptation. This stage therefore ignored the prioritisation process and instead set out initially to simply provide an analysis of climate change impacts on RES priority actions. Subsequently the impacts and opportunities were characterised in terms of direct and indirect effects, and their degree of significance. The outcomes provide analyses of climate change mitigation and impacts which draw on and are complimentary to those set out in previous chapters; furthermore they provide useful information in the context of managing RES delivery.

Table 6.1 identified impacts and opportunities related to mitigation policy on RES priority actions. The impacts and opportunities (final column) are characterised as direct (normal text) or indirect (italics) and as being of low significance (green box), some significance (orange box) or high significance (red box) to priority action. Note that the key impacts and opportunities identified in the conclusions of Chapter 5 largely correspond with those of high significance in Table 6.2. For information, the key priority actions are highlighted (with red text in the fourth column). A similar table is presented with respect to adaptation (Table 6.2).

It should be noted that for the purposes of mapping climate change risks and opportunities against development policies, the description of the policy priorities are generally provided in sufficient detail for their potential relevance to be identified. However, in some case the policy priorities are not described in terms that make clear precisely how the identified potential climate change impact will affect the fulfilment of the strategy. In this case, when defining the case studies in detail it is likely to be useful to identify the specific actions that have been developed to achieve the individual policy priority in practice.

Table 6.1 Threats and Opportunities of Mitigation Policies with respect to RES Priorities

Key to final column

Effect has high significance
Effect has medium significance
Effect has low significance

Aims	Strategic Priorities	Priority	Priority Action	Threats and Opportunities of Mitigation Policy
RAISING PRODUCTIVITY	Employment, Learning and Skills	Developing the skill levels of the current and future workforce	Engage Schools and Colleges with Businesses	*Energy efficiency education. Opportunity for school top join Ecoschools programme. Set up links between Carbon Trust and schools*
			Developing Adult Workforce Skills	*Adult Education courses to reflect skills needed in low carbon economy - e.g. BREEAM training, sustainable construction*
		Stimulating business demand for skills	Stimulating Skills Demand	*Awareness raising of CC business opportunities*
		Improving the infrastructure and responsiveness of skills supply	Matching Skills Provision to Employer Demand	*Encourage CC mitigation related courses at a university level (e.g. engineering at Loughborough and Nottingham)*
		Exploiting the opportunity of Higher Education	Exploiting the Opportunity of Higher Education	
	Enterprise and Business Support	Building an enterprise culture	Harness a Culture of Enterprise	*Financial support for climate change related businesses*
		Creating a dynamic SME base	Targeted Provision to Improve Business Creation	Ensure advice relating to business developments takes account of mitigation related planning requirements
		Supporting innovation and diversification in manufacturing	Supporting Innovation and Diversification in Manufacturing	Direct impact of CCL and EUETS on manufacturing - increased costs
				Education and support for energy efficiency and opportunities offered by CC e.g. new markets in solar panels, wind turbines etc
		Overcoming barriers to SME growth	Providing High Quality Business Support	*Incorporate Carbon Trust in business support network*
			Improving Access to Finance	Make support conditional on climate screening - sustainable construction, energy efficiency etc
		Supporting firms to become internationally competitive and attracting inward investment	Increasing International Trade	Make international trade support conditional on mutual CC agreements - similar to JI/CDM projects
			Targeting Foreign Direct Investment	Encourage investment in CC R+D e.g. fuel cell technology
		Building the visitor economy	Increasing Visitor Spend	Potential reduction in tourism from increase airline taxes, road pricing
		Harnessing culture in the East Midlands	Targeting Growth of Creative and Cultural Industries	
		Supporting SMEs to harness business	Maximising the Benefits of Public Procurement	*Needs to be generally sensitive to CC mitigation threats/opportunities*

Aims	Strategic Priorities	Priority	Priority Action	Threats and Opportunities of Mitigation Policy
		opportunities such as public procurement	Maximising the Benefits of the London 2012 Olympic and Paralympic Games	*Ensure Action Plan is climate proofed*
	Innovation	Increasing investment in research and development	Increasing Research & Development	Bias away from energy intensive sectors towards energy sensitive process design
			Developing Research Excellence	*Encourage and promote R+D in Region's universities*
		Helping existing businesses deploy technologies and processes	Developing and Applying New Technologies	Bias away from energy intensive sectors towards energy sensitive process design
		Resource efficiency through effective use of technology and management practices	Providing Business Support on Resource Efficiency	Base support on energy and resource efficiency
		Translating scientific excellence into business success	Maximising the Impact of Science City Nottingham	Bias away from energy-intensive sectors? Or towards energy-sensitive process design? *Support for CC related R+D - greater links with Region's universities*
			Commercialising Scientific Excellence through Facilitated Business Collaboration	*Opportunity for collaboration between universities and business on CC research issues*
			Development of Land and Property	Require high standards of energy efficiency in buildings
		Growing the regions key sectors	Growing the Region's Key Sectors	All issues mentioned elsewhere relevant here.
ENSURING SUSTAINABILITY	Transport and Logistics	Infrastructure, accessibility and connectivity	Improve Transport Connectivity and Accessibility	Opportunity for emissions reductions through use of sustainable transport - public transport, walking and cycling *Potential for increasing transport costs (road and fuel tax, road pricing, parking costs). Opportunity for expansion of public transport services.*
			Maximise Benefits of Nottingham East Midlands Airport and Robin Hood Airport	Policy conflict - increasing air traffic in the Region will cancel out all other mitigation efforts
			Travel Demand Management	Congestion and parking charging also possible. Stimulate demand for alternative fuels. *Potential for increasing transport costs (road and fuel tax, road pricing, parking costs). Opportunity for expansion of public transport services.*
	Energy and Resources	Responding to the challenge of climate change	Adaptation to Climate Change	
			Reducing the Demand for Energy and Resources	CCL, emissions trading, energy white paper all relevant. Energy efficiency commitment. *Education about domestic and industrial energy and water efficiency*

Aims	Strategic Priorities	Priority	Priority Action	Threats and Opportunities of Mitigation Policy
		Exploitation of new and growing low carbon markets	Utilising Renewable Energy Technologies	Planning permission for small scale renewables to be encouraged, financial support for domestic scale energy generation. *Promote R+D investment*
			Exploiting Low Carbon Technologies	Financial incentives to support low carbon strategies - increase competitiveness *Raise awareness of opportunities for ESCo's*
		Ensuring an infrastructure for a low carbon economy	Energy and Waste Capacity	Opportunities for energy from waste strategies - e.g. landfill gas, sewage sludge *Need to address infrastructure needs for decentralised energy generation. Opportunity for new nuclear build.*
	Environmental Protection	Protecting and enhancing our environmental infrastructure to ensure sustainable economic growth	Environmental Infrastructure	All issues mentioned elsewhere relevant here.
			Sustainable Construction	Recognise opportunities for carbon reduction and energy efficiency gains from sustainable development. Guidelines such as BREEAM and CSH to be followed.
			Cleaner Production Processes	Financial incentives to support clean production processes - increase Competitiveness *Shift to less carbon intensive products - new markets and new products*
		Protecting and enhancing green infrastructure through environmental stewardship	Improve Damaged Environments	Incorporate CC into policy *Increase and improve quality and quantity of forest in Region. Possible new markets for timber, miscanthus, short rotation coppice as energy/construction crops. Require change in land use to be climate proofed.*
			Protect and Enhance Green Infrastructure	Incorporate CC into policy *Carbon offset potential from creating wetlands, forests etc needs to be recognised. Opportunity to invest in biofuels.*
	Land and Development	Development land	Secure the Supply of Quality Employment Land	
			Infrastructure for Employment Related Schemes	*Potential to increase home working, teleconferencing etc to reduce transport emissions. Modal shift in freight transport towards rail/water. Opportunity for on-site energy generation - requires planning policy support*
			Previously Developed Land and Buildings	*Retro fitting of existing buildings with energy efficient appliances, insulation etc. Useful to have guidelines and best practice for existing building stock.*
		Housing	Supporting Infrastructure for Housing Growth	*Opportunity to encourage sustainable transport. Also encourage renewables and micro-generation. Promote mixed developments (housing, shopping, community facilities) to reduce need to travel.*
			Regeneration in Areas of Low Housing Demand	*Increase green infrastructure*

Aims	Strategic Priorities	Priority	Priority Action	Threats and Opportunities of Mitigation Policy
			Range of Housing Provision	*Sustainable construction, retrofitting.*
ACHIEVING EQUALITY	Cohesive Communities	Cohesive Communities	Promoting Social Capital	*Provision of community level environmental groups to raise awareness of CC*
			Collaboration to Encourage Participation	
			Develop Cohesive Communities	
	Economic Renewal	Building local capacity, resources and support	Effective Engagement and Involvement of Local Businesses and Residents	*Raise business CC awareness - highlight opportunities for economic regeneration, new markets, new jobs, new skills etc*
			Inclusive Business Support	
		Reviving local infrastructure and environments	Built and Green Environments	Sustainable construction best practice
			Addressing Crime	
		Stimulating new markets and enterprise opportunities	New Markets and Enterprise Opportunities	*Opportunities to exploit new markets and enterprise opportunities as a result of CC - new markets, new skills required etc*
			Improve Access to Finance	*Make support conditional on climate screening*
	Economic Inclusion	Employability	Enhance Employability of the Most Disadvantaged	
			Address Worklessness	
			Improving Diversity of the Workforce	
		Achieving a healthy workforce	Working With Employers to Improve the Health of the Region's Workforce	*Promotion of walking and cycling - reduced transport emissions*
			Address Ill Health as a Barrier to Employability	
		Enterprising people	Develop Entrepreneurship Skills	

Table 6.2 Threats and Opportunities of Climate Change Impacts and Adaptation with respect to RES Priorities

Key to final column

Effect has high significance
Effect has medium significance
Effect has low significance

Aims	Strategic Priorities	Priority	Priority Action	Threats and Opportunities of Climate Change Impacts and Adaptation
RAISING PRODUCTIVITY	Employment, Learning and Skills	Developing the skill levels of the current and future workforce	Engage Schools and Colleges with Businesses	*Energy efficiency education*
			Developing Adult Workforce Skills	
		Stimulating business demand for skills	Stimulating Skills Demand	
		Improving the infrastructure and responsiveness of skills supply	Matching Skills Provision to Employer Demand	*Encourage CC adaptation related courses at a university level (e.g. flood risk management)*
		Exploiting the opportunity of Higher Education	Exploiting the Opportunity of Higher Education	
	Enterprise and Business Support	Building an enterprise culture	Harness a Culture of Enterprise	
		Creating a dynamic SME base	Targeted Provision to Improve Business Creation	Ensure advice relating to business location us sensitive to spatial climate risks, e.g. flooding
		Supporting innovation and diversification in manufacturing	Supporting Innovation and Diversification in Manufacturing	*Opportunity to exploit new product markets, e.g. water collection systems*
		Overcoming barriers to SME growth	Providing High Quality Business Support	
			Improving Access to Finance	Make support conditional on climate screening – located out of flood plain, energy and water resource provision
		Supporting firms to become internationally competitive and attracting inward investment	Increasing International Trade	Recognise sector vulnerabilities related to CC impacts in overseas part of supply-demand chain or overseas market
			Targeting Foreign Direct Investment	Encourage investment in CC R+D e.g. flood risk management
		Building the visitor economy	Increasing Visitor Spend	Favourable weather brings more tourists. Impact on tourist attractions (e.g. PDNP). Year-round sporting opportunities *The Region could be marketed as 'eco-tourist' destination*
		Harnessing culture in the East Midlands	Targeting Growth of Creative and Cultural Industries	Loss of heritage sites (e.g. Lincs coast) and beaches. Impacts from sea-level rise, flooding.
		Supporting SMEs to harness business	Maximising the Benefits of Public Procurement	*Needs to be generally sensitive to CC adaptation threats/opportunities*

Aims	Strategic Priorities	Priority	Priority Action	Threats and Opportunities of Climate Change Impacts and Adaptation
		opportunities such as public procurement	Maximising the Benefits of the London 2012 Olympic and Paralympic Games	Year-round sporting opportunities
	Innovation	Increasing investment in research and development	Increasing Research & Development	*Recognise sectors that are climate sensitive and require R+D*
			Developing Research Excellence	*Encourage and promote R+D in Region's universities*
		Helping existing businesses deploy technologies and processes	Developing and Applying New Technologies	*Recognise sectors that are climate sensitive and require R+D*
		Resource efficiency through effective use of technology and management practices	Providing Business Support on Resource Efficiency	
		Translating scientific excellence into business success	Maximising the Impact of Science City Nottingham	
			Commercialising Scientific Excellence through Facilitated Business Collaboration	
			Development of Land and Property	Consideration of flood risk important in siting development. Buildings require climate sensitive design – ventilation, shade, etc
		Growing the regions key sectors	Growing the Region's Key Sectors	All issues mentioned elsewhere relevant here. *All issues mentioned elsewhere relevant here.*
ENSURING SUSTAINABILITY	Transport and Logistics	Infrastructure, accessibility and connectivity	Improve Transport Connectivity and Accessibility	Requires a consideration of CC impacts on new and existing infrastructure
				Warmer temperatures may encourage walking and cycling
			Maximise Benefits of Nottingham East Midlands Airport and Robin Hood Airport	Increased likelihood of flooding and fog may hinder aviation development
			Travel Demand Management	Increased occurrence of extreme weather may affect travel choices
				Warmer weather may increase demand for cycling infrastructure
	Energy and Resources	Responding to the challenge of climate change	Adaptation to Climate Change	
			Reducing the Demand for Energy and Resources	Reduced winter space heating demand, increased summer electricity demand for cooling and refrigeration. Potential damage to energy infrastructure (wind)
		Exploitation of new and growing low carbon markets	Utilising Renewable Energy Technologies	

Aims	Strategic Priorities	Priority	Priority Action	Threats and Opportunities of Climate Change Impacts and Adaptation
			Exploiting Low Carbon Technologies	
		Ensuring an infrastructure for a low carbon economy	Energy and Waste Capacity	Potential detrimental effects of extreme weather on energy infrastructure. Changing demand for energy
	Environmental Protection	Protecting and enhancing our environmental infrastructure to ensure sustainable economic growth	Environmental Infrastructure	All issues mentioned elsewhere relevant here. *All issues mentioned elsewhere relevant here.*
			Sustainable Construction	Recognise CC risks – especially location specific risks, e.g. flood risk.
			Cleaner Production Processes	
		Protecting and enhancing green infrastructure through environmental stewardship	Improve Damaged Environments	Threats to biodiversity from CC. Need to incorporate CC into adaptation policy for current and future habitat management. Risk of soil moisture loss and increase in erosion. Increased risk of fire, pests and disease
				Possibility for new species in the Region
			Protect and Enhance Green Infrastructure	Increase amount of green space to reduce flood risk
				Potential for green infrastructure to contribute to SUDS
	Land and Development	Development land	Secure the Supply of Quality Employment Land	Location specific threats – flooding
			Infrastructure for Employment Related Schemes	Extreme temperatures may require a more flexible working day
			Previously Developed Land and Buildings	Location specific threats - flooding
				Retrofitting ventilation systems, shutters and water meters
		Housing	Supporting Infrastructure for Housing Growth	Location specific threats - flooding
			Regeneration in Areas of Low Housing Demand	
			Range of Housing Provision	Location specific threats - flooding
ACHIEVING EQUALITY	Cohesive Communities	Cohesive Communities	Promoting Social Capital	*Provision of community level environmental groups to raise awareness of CC*
			Collaboration to Encourage Participation	
			Develop Cohesive	

Aims	Strategic Priorities	Priority	Priority Action	Threats and Opportunities of Climate Change Impacts and Adaptation
			Communities	
	Economic Renewal	Building local capacity, resources and support	Effective Engagement and Involvement of Local Businesses and Residents	*Raise business CC awareness - highlight opportunities for economic regeneration, new markets, new jobs, new skills etc*
			Inclusive Business Support	
		Reviving local infrastructure and environments	Built and Green Environments	Extreme weather may lead to problems of flooding, subsidence, etc. Threats to biodiversity. Need to alter plant species grown in the Region to cope with warmer conditions
				Opportunity to promote grey water recycling
			Addressing Crime	
		Stimulating new markets and enterprise opportunities	New Markets and Enterprise Opportunities	
			Improve Access to Finance	
	Economic Inclusion	Employability	Enhance Employability of the Most Disadvantaged	
			Address Worklessness	
			Improving Diversity of the Workforce	
		Achieving a healthy workforce	Working With Employers to Improve the Health of the Region's Workforce	Warmer weather – likely increase in walking and cycling.
			Address Ill Health as a Barrier to Employability	CC related impacts – temperature stress, food poisoning, and flooding-related risk of stress, injury and death
		Enterprising people	Develop Entrepreneurship Skills	

6.3 Stage 2

The review of regional policies (Chapter 2) served to identify the principal components and place them in relation to the RES. The eight RES priority actions that have been highlighted by Emda are:

- Developing Adult Workforce Skills
- Harness a Culture of Enterprise
- Targeted Provision to Improve Business Creation
- Commercialising Scientific Excellence through Facilitated Business Collaboration
- Growing the Region's Key Sectors
- Improve Transport Connectivity and Accessibility
- Energy and Waste Capacity
- Secure the Supply of Quality Employment Land

The review of linkages highlighted that five of these priority actions had little relevance to other Regional Strategies. In addition, the Stage 1 mapping indicates that climate change has no direct relevance to some of the priority actions. An example of this is: *Developing Adult Workforce Skills* - a priority highlighted by Emda, as shown above – but where a direct link with identified potential climate change impacts does not appear to exist. (Clearly, if, for example, the nature of the regional economy fundamentally changed due to a rapid shift to a low carbon economy, different workforce skills than those currently valued may become more needed and the identified actions to address this area should be sensitive. However, the link is rather indirect; the direct link would e.g. be with the actions within the regional Energy Action Plan).

In addition, Chapter 2 identified three RES actions that although not classed as key by Emda, had strong relevance to other regional strategies. These are:

- Maximising the benefit of Nottingham East Midlands Airport and Robin Hood Airport
- Environmental Infrastructure
- Supporting infrastructure for housing growth

The Stage 1 mapping exercise has identified that these areas are also significantly affected by climate change.

The policy prioritisation process has therefore resulted in six policy priorities for the region. One of those six, "Growing the Region's key Sectors" was thought too broad to be useful in subsequent analyses and was therefore split into the four economic sectors specified in the RES. The resulting list of regional policy priorities is:

- Growing the Region's key sectors – Transport Equipment
- Growing the Region's key sectors – Construction
- Growing the Region's key sectors – Food and Drink
- Growing the Region's key sectors – Healthcare
- Improve transport, accessibility and connectivity
- Energy and Waste Capacity
- Maximising the benefit of Nottingham East Midlands Airport and Robin Hood Airport
- Environmental Infrastructure
- Supporting infrastructure for housing growth

The key climate change threats and opportunities, identified in the conclusion of chapters 4 and 5, and reinforced in Stage 1 of the mapping and prioritisation exercise, can be seen in Table 6.3.

The priority policies and key threats and opportunities of climate change have now been identified, along with the relationship between them (see Tables 6.1 and 6.2 for a summary).

Table 6.3 Key Threats and Opportunities associated with Mitigation Policies and Climate Change Impacts

	Mitigation	Impacts / Adaptation
Threats	Energy – fossil fuel generation Transport – road and air Built environment – raw materials Manufacturing – road/air freight and distribution	Water resources – drought Flooding Biodiversity – loss of species Tourism – loss of heritage sites Transport – infrastructure Health – increase in heat-related illness and death
Opportunities	Energy – development of low carbon technologies Transport – public transport operators Built environment – sustainable construction Agriculture – bio energy and fuel	Agriculture – new crops Biodiversity – new species arrive Tourism – increased visitor numbers Health – reduction in cold-related deaths

6.4 Stage 3

The third and final stage of the mapping and prioritisation procedure was to select case studies from the possible pool of interactions between regional policy priorities and key climate change impacts identified in stage 2.

Tables 6.4 and 6.5 are matrices that map regional policy priorities (described using corresponding RES priority actions) against mitigation and impact threats and opportunities. Each box represents a possible case study. However, not all interactions between regional policy priorities and key climate change impacts are necessarily significant (see Tables 6.1 and 6.2). Furthermore, the number of case studies was limited. Therefore, it was necessary to select case studies. The selection process used a Multi-Criteria Analysis (MCA) approach, which was applied informally alongside expert knowledge and previous experience. The criteria considered in selecting the potential case studies are listed in Table 6.6. For many case studies it was necessary to further define the key climate change impact and narrow the focus of the policy priority; the criteria set out helped to achieve this. In addition, the feasibility of undertaking the case study was considered (in terms of data availability, timescale and utility of outcome) although this did not prevent significant interactions being represented.

Table 6.4 Case Studies Identified from the Interaction between Regional Policy Priorities and Key Climate Change Mitigation Policies

	Energy - fossil fuel generation	Transport - road and air	Built environment - raw materials	Manufacturing - road/air freight and distribution	Energy - development of low carbon technologies	Transport - public transport operators	Built environment - sustainable construction	Agriculture - bio energy and fuel
Growing the Region's Key Sectors - Transport Equipment		CS 1						
Growing the Region's Key Sectors - Construction			CS 3a				CS 3b	
Growing the Region's Key Sectors - Food and Drink	CS 5							
Growing the Region's Key Sectors - Healthcare	CS 2							
Improve Transport Connectivity and Accessibility		CS 6b		CS 6a				
Energy and Waste Capacity					CS 9			CS 4
Maximising the benefit of NEMA and Robin Hood Airport								
Environmental Infrastructure								
Supporting infrastructure for housing growth								
	Threats				Opportunities			

Note: Grey boxes denote case studies with specific geographic location

Table 6.5 Case Studies Identified from the Interaction between Regional Policy Priorities and Key Climate Change Impacts

	Water resources - drought	Flooding	Biodiversity - loss of species	Tourism - loss of heritage sites	Transport - infrastructure	Health - increase in heat-related illness and death	Agriculture - new crops	Biodiversity - new species arrive	Tourism - increased visitor numbers	Health - reduction in cold-related deaths
Growing the Region's Key Sectors - Transport Equipment										
Growing the Region's Key Sectors - Construction	CS 7a									
Growing the Region's Key Sectors - Food and Drink										
Growing the Region's Key Sectors - Healthcare										
Improve Transport Connectivity and Accessibility					CS 8					
Energy and Waste Capacity										
Maximising the benefit of NEMA and Robin Hood Airport										
Environmental Infrastructure			CS11						CS10	
Supporting infrastructure for housing growth		CS7b								
	Threats						Opportunities			

Note: Grey boxes denote case studies with specific geographic location

Table 6.6 Criteria Used in the Selection of Case Studies

Criteria	Definition
Magnitude	The severity of each potential consequence, in the sense of degree, extensiveness or scale. Does it cause a large change over baseline conditions? Does it cause a rapid rate of change – large changes over a short time? Will these changes exceed local capacity to address or incorporate change? Does it create a change which is unacceptable? Does it exceed a recognized threshold value?
Population affected	How pervasive will the consequences be across the population? That is, what portion of the population will be affected? To what extent will it will affect different demographic groups, particularly at vulnerable groups (e.g. children, elderly, pregnant women, etc.).
Socio-economic importance	The degree to which the potential consequences may (or may be perceived to) affect local economies or social structure.
Local sensitivity	To what extent is the local population aware of the consequence? Is it perceived to be significant? Has it been a source of previous concern in the community? Are there any organized interest groups likely to be mobilized by the consequence?
Geographical limits	This is the extent to which the consequences may eventually extend (e.g., local, regional, national), as well as to geographical location.
Reversibility	How long will it take to mitigate the consequence by natural or human means? Is it reversible, and, if so, can it be reversed in the short or long-term?
Duration & frequency	Length of time (day, year, decade) for which a consequence may be discernible. The nature of that consequence over time (is it intermittent and / or repetitive?) If repetitive, then how often?
Cumulative impact	The potential consequence that is achieved when identified risk scenarios occur together. Are threshold levels surpassed?
Likelihood or confidence	The probability of a consequence occurring.
Economic cost	How much is it likely to cost to mitigate the consequence? Who will pay? How soon will finances be needed to address this consequence?
Institutional capacity	What is the current institutional capacity for addressing the consequence? Is there an existing legal, regulatory, or service structure? Can the primary level of government (e.g. local government) deal with the consequence or does it require other levels or the private sector?

The result of the mapping and prioritisation process is a series of potential case studies that address a range of critical interactions between regional policies priorities and key climate change threats and opportunities. The potential case studies are described in detail in Chapter 7.

7 Case Studies

The completed templates below provide details of the case studies proposed for Stage 2 of the project. Fourteen possible case studies are outlined, where six (3 pairs) of these are closely related to each other and are presented as either/or choices to be made. The mix of case studies consist of: six with a mitigation focus and five with an adaptation focus. Three/four are presented as opportunities whilst eight/seven are presented as risks, depending on the options chosen.

7.1 Case Study 1

Focus	**Transport Equipment.**
Theme	Economic Sector – Mitigation Risk
Issue	Direct and indirect regulatory risk related to energy use and associated GHG emissions at manufacturing sites.
Key links to regional vision	Priority growth sector in RES
Scope issues	Aerospace and automotive sub-sectors throughout the region. Analysis at level of sub-sector, not at enterprise level. Direct impacts on sub-sector and associated indirect and induced effects on regional economy, where possible. Consideration of international dimension – specifically, the impacts on demand from the regulation of GHG emissions related to air travel in key markets for output from the sector.
Links to other case studies	Case study 6: Mitigation risk – transport infrastructure & use
Likely outcome	Estimate of change in likely change in production costs and profitability of sub-sector as the carbon externality is internalised. Indication of long-run implications for sub-sector (size of sector, employment). Associated impacts on regional economy, where relevant. Analysis of responses to risk, where mitigation measures can be identified in the published literature, including (qualitative) assessment of the implications for the regional economy.

7.2 Case Study 2

Focus	**Healthcare.**
Theme	Economic Sector – Mitigation Risk
Issue	Direct and indirect regulatory risk related to energy use and associated GHG emissions at manufacturing sites/NHS Estates.
Key links to regional vision	Priority growth sector in RES
Scope issues	Healthcare manufacturing sub-sectors throughout the region. Analysis at level of sub-sector, not at enterprise level. Direct impacts on sub-sector and associated indirect and induced effects on regional economy, where possible.
Links to other case studies	Case study 6: Mitigation risk – transport infrastructure & use
Likely outcome	Estimate of change in production costs and profitability of sub-sector as the carbon externality is internalised. Indication of long-run implications for sub-sector (size of sector, employment). Associated impacts on regional economy, where relevant. Analysis of responses to risk, where mitigation measures can be identified in the published literature, including (qualitative) assessment of the implications for the regional economy.

7.3 Case Study 3

Either

Focus	**Construction.**
Theme	Economic Sector – Mitigation Risk
Issue	Direct and indirect regulatory risk related to energy use and associated GHG emissions in creation and transport of raw materials for construction.
Key links to regional vision	Priority growth sector in RES
Scope issues	Analysis at level of sub-sector, not at enterprise level. Direct impacts on sub-sector and associated indirect and induced effects on regional economy, where possible.
Links to other case studies	Case study 6: Mitigation risk – transport infrastructure & use
Likely outcome	Estimate of change in production costs and profitability of sub-sector as the carbon externality is internalised. Indication of long-run implications for sub-sector (size of sector, employment). Associated impacts on regional economy, where relevant. Analysis of responses to risk, where mitigation measures can be identified in the published literature, including (qualitative) assessment of the implications for the regional economy.

Or

Focus	**Construction**
Theme	Economic Sector – Mitigation Opportunity
Issue	Opportunities in sustainable property design (including per unit reductions in GHG emissions) arising from large scale housing development in MKSM
Key links to regional vision	Priority growth sector in RES. Highlighted in RES Innovation: Translating scientific excellence into business success where "proposed developments …should encourage sustainable building design." Also, links to Environmental Protection (SP6)
Scope issues	Analysis focussed at level of sub-region, since maybe location-specific design issues. But supply chain may be located elsewhere in region/country. Direct impacts on sub-sector (property design) and associated indirect and induced effects on regional economy, where possible.
Links to other case studies	Case study 7: Impact risk – water management; Case study 9: Mitigation opportunity - Waste and Energy Infrastructure.
Likely outcome	Estimate of change in production costs and profitability of sub-sector as the carbon externality is internalised through design process. Indication of long-run implications for sub-sector (size of sector, employment). Associated impacts on regional economy, where relevant.

7.4 Case Study 4

Focus	**Agriculture.**
Theme	Economic Sector – Mitigation Opportunity
Issue	Conversion and use of agricultural land for bio-fuel supply.
Key links to regional vision	Relates to Land & Development (SP7); Energy & Resources (SP5), and Environmental Protection (SP6) in RES; Regional Spatial Strategy – Priority 23: Regional Priorities for Rural Diversification
Scope issues	Analysis at level of sub-sector, not at enterprise level. Focus likely on specific sub-regions. Direct impacts on sub-sector and associated indirect and induced effects on regional economy, where possible.
Links to other case studies	Case study 6: Mitigation risk – transport infrastructure & use; Case study 9: Mitigation opportunity - Waste and Energy Infrastructure; Case study 7: Impact risk – water management
Likely outcome	Estimate of change in income and profitability of sub-sector under (current support regime) agriculture policy scenario. Indication of long-run implications for sub-sector (size of sector, employment). Associated impacts on regional economy, where relevant.

7.5 Case Study 5

Focus	**Food and Drink.**
Theme	Economic Sector – Impact Risk
Issue	Risk to Supply chain from regional, national and international climate change impacts
Key links to regional vision	Priority growth sector in RES
Scope issues	Food and drink sub-sectors throughout the region. Analysis at level of sub-sector, not at enterprise level. Direct impacts on sub-sector and associated indirect and induced effects on regional economy, where possible. Consideration of international dimension – e.g., the impacts on demand from the regulation of GHG emissions related to air travel in key markets for output from the sector or the effect of climate impacts on supply of foodstuffs from overseas.
Links to other case studies	Case study 7: Impact risk – water management
Likely outcome	Estimate of change in production costs and profitability of sub-sector as key potential climate impacts (including on foodstuffs, water resources) are taken into account. Indication of long-run implications for sub-sector (size of sector, employment). Associated impacts on regional economy, where relevant. Analysis of responses to risk, where adaptation measures can be identified in the published literature, including (qualitative) assessment of the implications for the regional economy.

7.6 Case Study 6

Either

Focus	**Transport Infrastructure and Use.**
Theme	Economic Sector – Mitigation Risk
Issue	Direct and indirect regulatory risk related to energy use and GHG emissions associated with freight transport and distribution.
Key links to regional vision	Link primarily to Regional Transport Strategy, RES Transport & logistics (SP4) and RES Environmental Protection (SP6)
Scope issues	Focus on analysis of likely key initiatives in mitigation within transport sector e.g. inclusion of vehicle fleets within ETS or emission charging regimes. Likely to benefit from use of PTOLEMY model for quantitative analysis. Direct impacts on sub-sector and associated indirect and induced effects on regional economy, where possible. Consideration of international dimension – specifically, the impacts on demand from the regulation of GHG emissions related to freight travel in key markets.
Links to other case studies	Case studies 1-6.
Likely outcome	Estimate of change in demand for freight & logistics sub-sector and use of transport infrastructure as the carbon externality is internalised. Indication of long-run implications for sub-sector (size of sector, employment). Associated impacts on regional economy, where relevant.

Or

Focus	**Transport Infrastructure and Use.**
Theme	Economic Sector – Mitigation Risk
Issue	Direct and indirect regulatory risk related to energy use and GHG emissions associated with expansion of Nottingham East Midlands Airport.
Key links to regional vision	Link primarily to Regional Transport Strategy, RES Transport & logistics (SP4) and RES Environmental Protection (SP6)
Scope issues	Focus on analysis of likely key initiatives in mitigation within air transport sector e.g. inclusion of airline companies within ETS Direct impacts on sub-sector and associated indirect and induced effects on regional economy, where possible. Consideration of international dimension – specifically, the impacts on demand from the regulation of GHG emissions related to air travel in key markets.
Links to other case studies	Case studies 1-6.
Likely outcome	Estimate of change in demand for freight & logistics sub-sector and use of transport infrastructure as the carbon externality is internalised. Indication of long-run implications for sub-sector (size of sector, employment). Associated impacts on regional economy, where relevant.

7.7 Case Study 7

Either

Focus	**Water management.**
Theme	Geographic Sector – Impact Risk
Issue	Household demand for water resources in MKSM
Key links to regional vision	Regional Water Resources Strategy; RES Environmental Protection (SP6) Regional Spatial Strategy – Priority 32: A Regional Approach to Water Resources and water quality.
Scope issues	Analysis of regional water demand profile, incorporating planned sub-regional growth area developments. Likely to require modelling using Anglian Water's FORWARD water resource balance model.
Links to other case studies	Case studies 3-5
Likely outcome	Estimate of change in projected water resource shortfalls as a consequence of combined socio-economic and climate change in MKSM sub-regional growth area. Water resource shortfalls to be expressed in welfare loss terms using econometric analysis of willingness to pay for resources. Quantitative analysis of responses to risk, where adaptation measures can be identified in the published literature, including estimation of net benefits from adaptation. To include (qualitative) assessment of the implications for the regional economy.

Or

Focus	**Water management.**
Theme	Geographic Sector – Impact Risk
Issue	Increased risk from riverine or coastal or urban drainage flooding
Key links to regional vision	Link primarily to Regional Spatial Strategy e.g. P35: A Regional Approach to Managing Flood Risk; P34 Priorities for the Management of the Lincolnshire Coast. RES Environmental Protection (SP6): Raising awareness of climate change factors on the built environment
Scope issues	Analysis to complement and build on Faber Maunsell (2006) by: a) monetising flood impacts, including health, and; b) indicate, where already undertaken, how Strategic Flood Risk Assessments (SFRA) need to be modified to account for climate change-induced flood risk.
Links to other case studies	Case studies 3-5
Likely outcome	Estimates of cost of climate change-induced flooding (coastal, riverine or urban) under alternative socio-economic and climate scenarios. Quantitative analysis of responses to risk, where adaptation measures can be identified in the published literature, including estimation of net benefits from adaptation. To include (qualitative) assessment of the implications for the regional economy.

7.8 Case Study 8

Focus	**Transport Infrastructure.**
Theme	Geographic Sector – Impact Risk
Issue	Road subsidence as a result of more frequent warm, dry summers under climate change
Key links to regional vision	Link primarily to Regional Transport Strategy, and; Transport & logistics (SP4): Infrastructure, accessibility and connectivity, in RES
Scope issues	Quantitative analysis of impacts of climate change on road transport infrastructure. Specific risks include: subsidence and associated disruption, travel time losses and repair costs. Potential modelling (PTOLEMY) of transport strategy responses to accommodate subsidence in specific sub-regions. Or qualitative indication of potential (sub-) regional transport strategy responses
Links to other case studies	Case studies 1-6; 10-11
Likely outcome	Estimates of cost of climate change-induced road subsidence under alternative socio-economic and climate scenarios. Analysis of responses to risk, and potential impacts on transport strategy and regional spatial development.

7.9 Case Study 9

Focus	**Waste and Energy Infrastructure.**
Theme	Geographic Sector – Mitigation Opportunity
Issue	Opportunity for development and exploitation of low carbon technological solutions to the spatial challenge of MKSM sub-regional growth area.
Key links to regional vision	Link primarily to Regional Spatial Strategy – Priorities 37-39; Regional Energy Strategy, and; RES Energy & Resources (SP5) Priority Actions
Scope issues	Analysis focussed at level of sub-region, since maybe location-specific technology development issues. But supply chain may be located elsewhere in region/country. Direct impacts on sub-sector (energy/waste system design) and associated indirect and induced effects on regional economy, where possible.
Links to other case studies	Case studies 3-4
Likely outcome	Estimate of change in production costs and profitability of sub-sector as the carbon externality is internalised through design process. Indication of long-run implications for sub-sector (size of sector, employment). Associated impacts on regional economy, where relevant.

7.10 Case Study 10

Focus	**Tourism**
Theme	Geographic Sector – Impact Opportunity
Issue	Potential growth of visitor economy under climate change scenarios.
Key links to regional vision	Link primarily to Regional Spatial Strategy e.g. P9 & P13
Scope issues	Analysis focussed at level of sub-region Estimates of changes in patterns of projected visitor numbers as a consequence of combined socio-economic and climate change in Peak District and Three Cities sub-regions. Analysis of infrastructure constraints and strategies to accommodate changing patterns in visitor economy.
Links to other case studies	Case study 8: Transport infrastructure; Case study 11: Green infrastructure
Likely outcome	Quantitative assessment of potential changes in patterns of visitor economy at sub-region or regional scale. Analysis of responses to likely opportunity, including (qualitative) assessment of the implications for the regional economy.

7.11 Case Study 11

Focus	**Environmental Infrastructure**
Theme	Geographic Sector – Impact Risk
Issue	Direct climate change impact on a) Peak district and b) coastal ecosystems
Key links to regional vision	Link primarily to Regional Environmental Strategy; Regional Biodiversity Strategy; Regional Economic Strategy e.g. RES Environmental Protection (SP6) e.g. Protecting and enhancing Green Infrastructure through environmental stewardship; Regional Spatial Strategy e.g. P26: Protecting and Enhancing the Region's Natural and Cultural Assets
Scope issues	Analysis to complement and build on Middlemarch Environmental Ltd (2006) by: a) Identifying the options available to restore habitats damaged directly by climate change b) Assessing the costs needed to restore such habitats, in order to identify cost-effective adaptation strategies
Links to other case studies	Links primarily with Case study 7: Water management
Likely outcome	Analysis of responses to risk, where adaptation measures can be identified in the published literature.

8 Conclusions

This report documents the work undertaken in Stage 1 of the study, and has identified a series of potential case studies which will form Stage 2. These case studies represent critical interactions between regional policy priorities and key threats and opportunities of climate change impacts and mitigation policies, all of which have been identified in subsequent chapters of this report. In summary the potential case studies are:

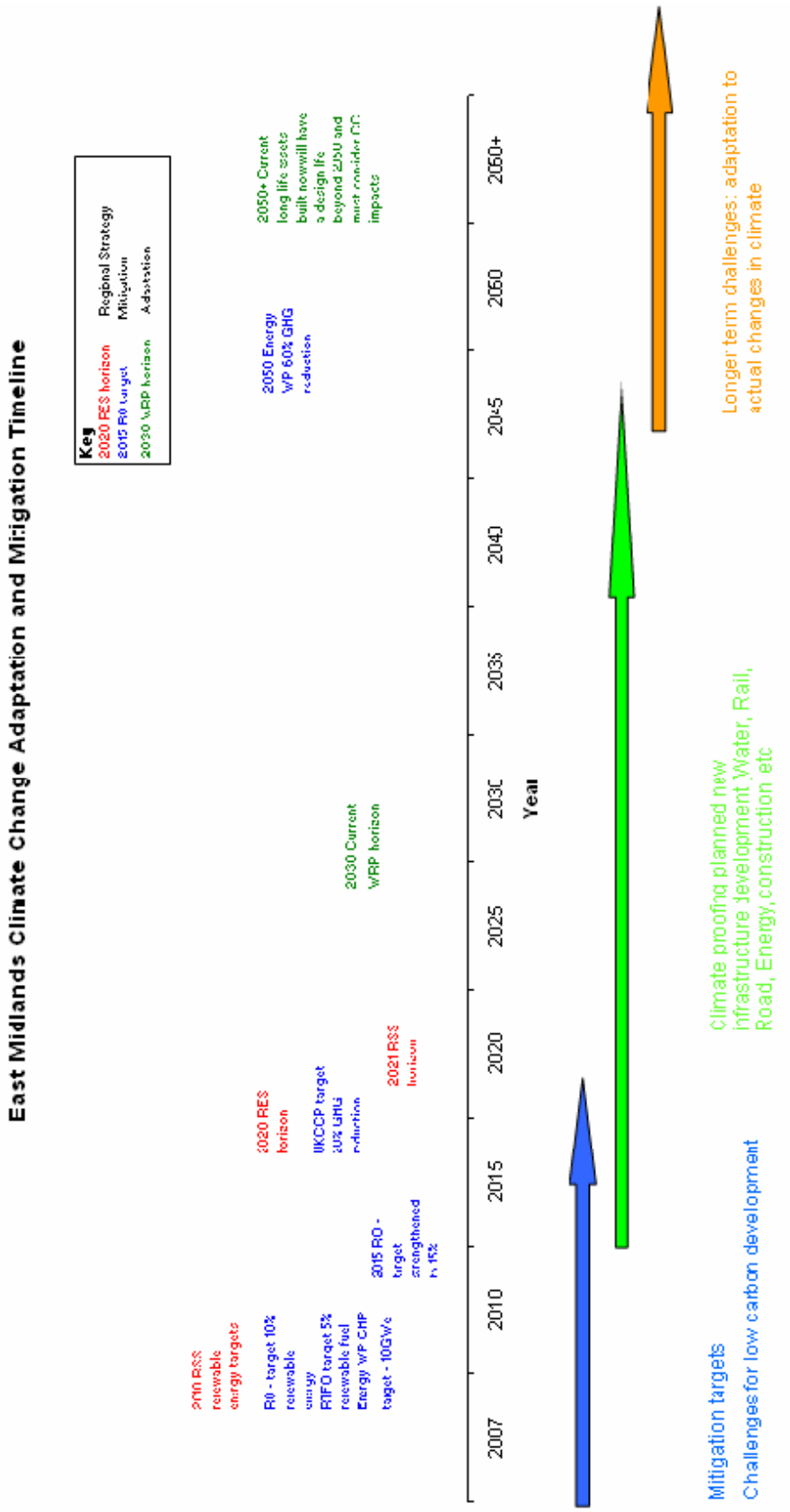
1. Mitigation risk to the transport equipment economic sector.
2. Mitigation risk to the healthcare economic sector.
3. Mitigation
    a. Risk to the construction economic sector; or
    b. Opportunity for the construction economic sector (with a focus on the South Midlands growth area / sub-region).
4. Mitigation opportunity for the agricultural economic sector (relating to biofuel supply).
5. Impact risk to the food and drink economic sector.
6. Mitigation risk to the transport infrastructure and use economic sector:
    a. Relating to freight transport and distribution; or
    b. Relating to the expansion of the Nottingham East Midlands Airport
7. Impact risk to the water management geographical sector:
    a. Relating to water resources (with a focus on the South Midlands growth area / sub-region); or
    b. Relating to flood risk (focus to be defined)
8. Impact risk to transport infrastructure geographical sector (focus to be defined).
9. Mitigation opportunity for waste and energy infrastructure geographical sector (with a focus on the South Midlands growth area / sub-region).
10. Impact opportunity for tourism geographical sector (with a focus on the Peak District and Three Cities sub-regions).
11. Impact risk to environmental infrastructure geographical sector (with a focus on the Peak District and coastal ecosystems).

There is scope within case studies 1, 5 or 6 for a high level view of international linkages.

These potential case studies, including the options presented, will be discussed and agreed at the Project Steering Group meeting on 8 February.

An indicative timeline describing critical points for mitigation and adaptation action, climate change impacts and regional strategy horizons has been prepared (see Figure 8.1). This sets out the key dates by which various actions should be met, or highlights where impacts may be experienced in relation to the timing of planning and asset management. Timescales will be considered further in the context of each case study in Stage 2.

Figure 8.1 East Midlands Climate Change Adaptation and Mitigation Timeline



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10 Appendices

Appendix A: Mitigation Policy Review
Appendix B: RES Priority Actions and Mapping with Other Regional Policies

Appendix A: Mitigation Policy Review

International

Kyoto Protocol

The Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) was the first international agreement on climate change. It was adopted at the Third Session of the Conference of the Parties (COP) to the UNFCC in 1997 in Kyoto, Japan. Countries included in Annex B of the Protocol (most OECD countries, including the UK, and countries with economies in transition) agreed to reduce their collective anthropogenic greenhouse gas emissions by at least 5% below 1990 by 2012. The Kyoto Protocol entered into force on the 16th February 2005.

The Kyoto Protocol makes provision for climate change mitigation in a number of ways;

- International emissions trading between Annex I countries (Parties include the industrialized countries that were members of the OECD in 1992, plus countries with economies in transition).
- Clean Development Mechanism - Annex I countries implement projects in non-Annex I countries that reduce emissions and use the resulting certified emission reductions (CERs) to help meet their own targets.
- Joint Implementation - Annex I countries implement projects that reduces emissions or increases removals by sinks in the territory of another Annex I country and count the resulting emission reduction units (ERUs) against its own target.

The European Commission negotiates on climate change as a single unit. The EU15 agreed 8% reduction in GHG emissions relative to 1990 levels by 2012 has been shared between the member states in a Burden Sharing Agreement. Analysis from the European Environment Agency shows that the EU15 is 2.3 percentage points away from a hypothetical linear path between 1990 and the 2008 - 2012 target. What it also shows is that some countries are doing better than others: Spain still has a long way to go to reach its target, whereas the UK and Sweden appear on track to meet their commitment.

The UK submitted its climate change progress report to the European Commission, and to UNFCCC in March 2006. The report shows that UK greenhouse gas emissions were 14.6 percent below base year levels in 2004; under its Kyoto Protocol target of 12.5%. However, this does not imply that there is room for complacency in the UK; GHG emissions have been rising annually for the last three years (Prof. David Read, Vice-president of the Royal Society, quoted in Connor 2006).

EU Climate Change Programme

The first phase of the European Climate Change Programme (ECCP) was launched in 2000 with a goal to identify and develop all the necessary elements of an EU strategy to implement the Kyoto Protocol. In the first report (ECCP, 2001), forty-two measures to reduce GHG emissions were proposed covering emissions trading, energy efficiency, renewable energy, transport and industrial processes.

One of the most important and innovative initiatives to come out of the ECCP is the EU Emissions Trading Scheme (EU ETS), which at present covers carbon dioxide emissions from some 11,500 large emitters in the power generation and manufacturing sectors. It began on 1st January 2005 and has been described as “the cornerstone of policies designed to achieve the targets of the Kyoto agreement” (Haar and Haar, 2005; 1). The aim of the EU ETS is to reduce emissions cost-effectively by facilitating the trading of allowances between installations, such that allowances flow to their highest valued use.

The second phase of the ECCP was launched in 2005 at a major stakeholder conference in Brussels. In addition to the six working groups convened during phase 1, groups covering carbon capture and geological storage, CO2 emissions from light-duty vehicles and emissions from aviation have been set up. One working group will also assess the implementation of the ECCP I policies and measures in the Member States and their effects in terms of emission reductions. This will feed into a broader ECCP I review process and give guidance to the Commission and the Member States on any supplementary efforts that may be needed to meet the EU's Kyoto commitment.

Energy Performance of Buildings Directive

The Energy Performance of Buildings Directive (EPBD) was published in the Official Journal of the European Commission in 2003. The overall objective of the Directive is to promote the improvement of energy performance of buildings within the Community taking into account outdoor climatic and local conditions, as well as indoor climate requirements and cost-effectiveness'. The Directive is set to promote the improvement of energy performance of buildings with the following four requirements to be fully implemented by the Member States by 2009:

- General framework for a methodology of calculation of the integrated performance of buildings;
- Setting of minimum standards in new and existing buildings;
- Energy Certification of Buildings;
- Inspection and assessment of heating and cooling installations.

The policies outlined in this directive will assist the EU in reducing GHG emissions from the built environment by influencing choice of construction materials and reducing the energy demand from heating, cooling and lighting devices.

National

UK Climate Change Programme

EU climate change legislation is transposed into UK policy through the UK Climate Change Programme (CCP). The first UK CCP was launched in 2000 (DETR, 2000) and was updated in 2006 (Defra, 2006).

Under the EU Burden Sharing Agreement the UK has a target of a 12.5% reduction in GHG emissions relative to 1990 levels by 2008 - 2012. In addition to this, the UK has adopted a more challenging target of a 20% reduction by 2020 (DETR, 2000) and aspires to a 60% reduction by 2050 (DTI, 2003). A number of policy and legislative instruments to address these targets are brought together in the UK CCP. These include:

- Climate Change Levy (CCL) – a levy on business use of energy set at a different rate for each type of fuel used. Discounts of up to 80% are available to energy intensive industries that enter into energy efficiency or emission reduction targets (known as Climate Change Agreements).
- Renewables Obligation (RO) – a market mechanism to increase installation of renewable energy such that 10% of grid-generated energy is provided by renewable energy by 2010.
- UK Emissions Trading Scheme (UK ETS) – a domestic ETS that pre-dated the wider EU scheme. Now finished.
- Voluntary Agreements (VA) package in the transport sector.
- Reform of company car taxation and graduated Vehicle Excise Duty (VED).

- Renewable Transport Fuel Obligation (RTFO) – requirement that oil companies and importers ensure that 5% of their road fuel sales are from a renewable source.
- Energy Efficiency Commitment (EEC) - electricity and gas suppliers are required to achieve targets for the promotion of improvements in domestic energy efficiency.

Energy White Paper

The DTI published the last energy white paper in 2003 entitled "Our Energy Future; creating a low carbon economy" (DTI, 2003). The most significant policy relating to climate change was the adoption of the Royal Commission on Environmental Pollution's target of a 60% reduction in GHG emissions by 2050 (RCEP, 2000). At the same time as meeting this target, the government are committed to maintaining reliability of supply, promoting competitive markets and eradicating fuel poverty.

The White Paper also announced increased support for energy efficiency measures and renewable energy. A target of 10GWe of good quality CHP capacity to be installed by 2010 was set and there was an aspiration to double the renewables share of electricity generation.

The Energy White Paper was followed up in 2006 with an Energy Review (DTI, 2006). The review proposes a number of measures covering energy efficiency, transport, renewable energy, nuclear energy and low carbon technologies including:

- Home Information Packs containing information on energy efficiency of dwellings;
- Phasing out of inefficient light bulbs;
- Press the EU to include road transport and aviation in the EU ETS;
- Reform of planning regime for electricity (including nuclear) projects;
- Strengthening the Renewables Obligation (RO) to 15% by 2015-16;
- A commercial demonstration of carbon capture and storage.

Transport White Paper

The Transport White Paper (DfT, 2004) extends investment plans until 2014-15 and covers all modes of transport. The focus is on sustained investment, improvements to transport management and planning ahead. Whilst there are some measures that may have a detrimental affect on UK emissions (new road building and airport expansion) there are many that may contribute to the mitigation of GHG emissions:

- Road pricing;
- Promote light rail;
- Provide funds for better bus services through the Transport Innovation Fund;
- Extended the Rural Bus Subsidy Grant;
- Encouraging local targets for walking and cycling;
- Lorry road user charging – encouraging modal shift in the freight sector.

UK Sustainable Development Strategy

The UK Strategy for sustainable development (Defra, 2005) aims to enable people to satisfy their basic needs and enjoy a better quality of life without compromising the quality of life of future generations. There are four agreed priorities of which one is climate change. In addition to the measures already described under other policies, the sustainable development strategy includes measures to:

- Engage in discussion at an international level on further engagement of all Parties to the UNFCCC on post 2012 action to reduce GHG emissions;
- Press for the inclusion of intra-EU air services in the EU ETS from 2008 or as soon as possible thereafter;
- Launch the Climate Change Communication Initiative with funding of £12 million over the period 2005 – 2008.

Utilities Act

Policies to improve energy efficiency are encompassed in the Utilities Act 2000. Energy suppliers are now under an obligation to encourage or assist consumers to be more energy efficient and take up energy saving opportunities. The government sets Energy Efficiency Commitments but leave it up to electricity and gas suppliers to decide how they will offer energy efficiency measures as part of their package of services to consumers.

Building Regulations

New regulations regarding energy and water efficiency of buildings came into force on the 6th April 2006. The 2000 Building Regulations had to be revised in order to meet with the requirements of the EU Directive on the energy performance of buildings (EU EPBD). The revisions to Part L set maximum carbon dioxide emissions for whole buildings. The net reduction of 40% from pre-2002 is often used as an indicator of improvement. The regulations apply both to the construction of new buildings and renovation of existing buildings with a total surface area over 1,000m².

Home Energy Conservation Act

The Home Energy Conservation Act 1995 (HECA) requires every UK local authority with housing responsibilities - "energy conservation authorities" - to prepare, publish and submit to the Secretary of State an energy conservation report identifying practicable and cost-effective measures to significantly improve the energy efficiency of all residential accommodation in their area; and to report on progress made in implementing the measures.

The Code for Sustainable Homes (DCLG, 2006) will form the basis of future developments to the building regulations and as such provides some regulatory certainty for developers. However, it is not statutory; developers voluntarily agree to implement it. It is possible that it will become mandatory for new developments in future. The Code comprises a single national standard for sustainable homes and measures dwellings against nine design categories; energy, water, materials, surface-water runoff, waste, pollution, health and well being, management and ecology. The code uses a star system to rate homes and it is up to the developer to choose which and how many standards they implement.

Regional

Regional Environmental Strategy

The East Midlands Regional Environmental Strategy, prepared by EMRA (EMRA, 2002), is a response to the four sustainable development objectives set out in the Integrated Regional Strategy (IRS). The IRS is the Sustainable Development Strategy for the region, developed by EMRA to ensure that policies and strategies in the region are compatible and more sustainable. Policies for the East Midlands Environment are split into five components; People and Heritage, Air, Land and Land Use, Water and Natural Heritage. Climate change is a theme that cuts across all the policy areas and there are many policies that directly or indirectly relate to mitigation, see Table 10.1. The Strategy also recognises that climate change may bring opportunities to the region.

Table 10.1 Policies in the Regional Environmental Strategy contributing to mitigation

ENV4 To encourage the use of environmentally friendly methods of travel;
ENV 6 To minimise greenhouse gas emissions and protect the environment when adapting to the challenges and taking up the opportunities which climate change will bring;
ENV 8 To seek to support the implementation of energy efficiency and renewable energy schemes to at least the level of the targets set out in the Regional Planning Guidance in order to achieve the wider environmental benefits of such action, whilst minimising any adverse environmental impacts from energy installations, their associated infrastructure and operation;
ENV 14 To use appropriate high quality materials and design to optimise the environmental benefits of built development, contributing to the 'urban renaissance';
ENV 16 To promote and support sustainable waste management practices and minimise the impact of waste on the environment;

Regional Energy Strategy

The Regional Energy Strategy comprises three parts:

- Part 1 – The East Midlands Energy Challenge
- Part 2 – A Framework for Action
- Part 3 – Implementation Plan

The Strategy is based on the seventeen policies set out in the Regional Energy Policy (EMRA, 2004), (see Table 10.2), and has been developed within the framework of the IRS. The Framework for Action identifies seven priorities and groups them under three work strands; Energy for Communities, Energy for Enterprise and Communicating the Energy Challenge. Each of the seven priorities addresses one or more of the seventeen policies set out in the Regional Energy Policy (EMRA, 2004), see Table 10.2. Responsibility for each work strand is assigned to a regional stakeholder. The organisation of the Strategy is shown in Figure 10.1.

Table 10.2 Summary of Regional Energy Policy

ENG1 To ensure that greenhouse gas emissions are significantly reduced to protect the Region from future impacts of climate change;
ENG 2 To encourage high standards of building design and renovation, which allow for good indoor environment, whilst reducing the energy demands for heating lighting and cooling;
ENG 3 To ensure that planners and building professionals are aware of the opportunities to minimise energy use in buildings and for transport through careful siting and design of new developments;
ENG 4 To encourage people and communities to reduce the impact that their use of energy has on their local and global environment, particularly in relation to climate change;
ENG 5 To equip people with the skills and knowledge to respond to the changing energy market;
ENG 6 To promote and support the improvement in energy efficiency as a means of improving the condition of homes and health;

ENG 7 To promote and support the improvement in energy efficiency as a means of improving the competitiveness of the Region's industrial base and of protecting valuable natural resources;

ENG 8 To promote and support the development of energy service companies within the Region;

ENG 9 To promote and support the development of markets for heat, recognising that heat is as an important commodity for energy services in homes and businesses;

ENG 10 To ensure that an increasing amount of the electricity used is generated from renewable sources;

ENG 11 To promote and support a growing market in renewable energy electricity generation;

ENG 12 To ensure that renewable energy installations or developments are designed sensitively to take full account of their impact on the historic or natural environment;

ENG 13 To encourage the uptake of domestic and small scale community owned or run renewable energy schemes;

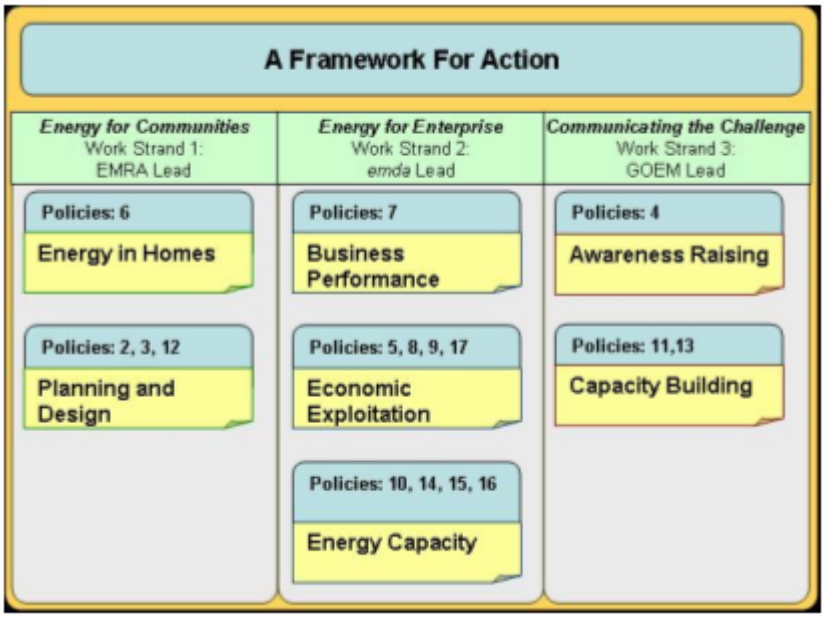
ENG 14 To promote and support the use of cleaner fossil fuel technologies in buildings and transport;

ENG 15 To ensure that the energy infrastructure in the East Midlands is maintained and enhanced for a reliable and secure energy supply, that is accessible to new generation capacity;

ENG 16 To support the energy generation and supply industries within the East Midlands and promote a shift to a low carbon economy;

ENG 17 To encourage research into new and emerging technologies and support mechanisms for their deployment.

Figure 10.1 Organisation of the Regional Energy Strategy (EMRA, 2004)



Regional Spatial Strategy

The Regional Spatial Strategy (RSS) provides a broad development strategy for the East Midlands up to 2021. There are 10 Regional Core Objectives of which one is "to take action to reduce the scale and impact of climate change in particular the risk of damage to life and property from flooding, especially through the location and design of new development". Reducing the 'scale' of climate change can be interpreted as a statement of intent to take action to mitigate GHG emissions. The policies are split into regional and sector specific categories. There are many policies contained within the RSS that affect mitigation, see Table 10.3.

Table 10.3 RSS policies contributing to mitigation

Policy 4 Design and construction that minimises energy use, improves water efficiency, reduces waste and pollution, and incorporates renewable energy technologies and sustainably sourced materials wherever possible;
Policy 23 Prevent the development of additional regional scale out-of-town retail and leisure floor space;
Policy 26 Promote the take up and use of ICT by businesses, and the public and voluntary sectors;
Policy 33 Manage supply and demand, require sustainable drainage where practicable and promote the efficient use of water;
Policy 40 Local authorities, energy generators and other agencies should promote: • Reduction of energy usage at the regional level in line with the 'energy hierarchy'; and • the development of Combined Heat and Power (CHP) and district heating infrastructure necessary to achieve the regional target of 511 MWe by 2010 and1120 MWe by 2020;
Policy 41 In making provision for new development policies should be supportive of renewable energy proposals in locations where environmental, economic and social impacts can be addressed satisfactorily.

Regional Transport Strategy

The Regional Transport Strategy is incorporated into the Regional Spatial Strategy for the East Midlands (GOEM, 2005). The core strategy is centred on four principles:

- Reduce the need to travel;
- Promote a change in the level of public transport;
- Better management of existing networks;
- Only build roads if all other options have been exhausted.

Similarly to transport policy at the national level, there are some policies which have a negative effect on GHG emissions but overall there is a stronger presumption towards modal shift and sustainable development. Policies have been drawn up that affect the whole region but there are also some geographically specific policies relating to each of the sub-areas identified in the RSS. Policies relevant to GHG emissions are summarised in Table 10.4.

Table 10.4 Summary of Regional Transport Strategy Policies impacting on mitigation

Policy 44 Regional Traffic Growth Reduction Local authorities, public and local bodies, and service providers should work together to achieve a progressive reduction over time in the rate of traffic growth in the East Midlands. **Policy 45** Behavioural Change The Regional Assembly, with Government, public and local bodies, and service providers, should work together to develop and implement measures for behavioural change to encourage a reduction in the need to travel and to change public attitudes toward car usage and public transport, walking and cycling. **Policy 51** Regional Priorities for Integrating Public Transport Local authorities, public bodies and service providers should work in partnership to increase the level of bus and light rail patronage at the regional level towards the national target of 12% by 2010. **Policy 54** Development of a Regional Freight Strategy Promote a more sustainable and efficient distribution industry in the East Midlands and contribute to a significant modal shift of freight from road to rail.

Local

Local Authority Strategies

There are a number of local authorities in the East Midlands region who have developed climate change strategies and policies. At a county level, Leicestershire and Nottinghamshire have both developed climate change strategies including targets and policies. At a more local scale some city and district councils have also drawn up climate change plans. Some Local Planning Authorities have produced Supplementary Planning Guidance on topics such as wind energy and green design (e.g. Sherwood District Council, Lincoln City Council).

Councils for Climate Protection

The UK Councils for Climate Protection scheme, run by Defra, was launched in 2000. There are 24 councils from across the UK taking part in the pilot, including the City of Leicester Council. The project takes an innovative approach to understanding the contribution that the council is making to global carbon dioxide pollution and developing a strategy to mitigate this pollution. There are five stages to the project:

- Carrying out a base-line emissions analysis and a forecast of emissions in a target year;
- Setting an emissions reduction target;
- Developing and adopting a Local Action Plan to reach that target;
- Implementing the Action Plan;
- Monitoring and reporting on emissions and the implications of policies and action.

Nottingham Declaration on Climate Change

To make public their commitment to address climate change, 100 councils have signed the Nottingham Declaration on Climate Change. This includes half of the 46 local authorities in the East Midlands region (EMRA Press Release, 2006). Signing the declaration requires councils to work with local stakeholders to address the causes and effects of climate change. Local authorities seeking to deal with climate change need to consider taking action in two complementary ways; mitigation and adaptation.

Appendix B: RES Priority Actions and Mapping with Other Regional Policies

Table 10.5 RES Priorities and Priority Actions

Aim	Priority	Priority Action	Description of Priority Action
Employment, Learning and Skills	Developing the skill levels of the current and future workforce	Engage Schools and Colleges with Businesses	Equip school and college leavers with the skills and knowledge that businesses require
		Developing Adult Workforce Skills	Increase the proportion of the adult workforce studying for and gaining new qualifications by developing clear learning pathways for people in work
	Stimulating business demand for skills	Stimulating Skills Demand	Encourage employers to stimulate demand for high level and transferable skills
	Improving the infrastructure and responsiveness of skills supply	Matching Skills Provision to Employer Demand	Prioritise resources in order to further develop the education and training infrastructure, capacity and quality assurance in order to deliver the skills demanded by employers
	Exploiting the opportunity of Higher Education	Exploiting the Opportunity of Higher Education	Ensure that adult learners, irrespective of age, gender or location, have access to academic and vocational qualifications to Level 4
Enterprise and Business Support	Building an enterprise culture	Harness a Culture of Enterprise	Create a continuous path of enterprise education and awareness available to all in the region, linked to the provision of start-up assistance for those who wish to access it
	Creating a dynamic SME base	Targeted Provision to Improve Business Creation	Create a coordinated long-term campaign to develop enterprise skills, raise the profile of enterprise and help people identify opportunities; focusing on people aged 35-55, particularly women.
	Supporting innovation and diversification in manufacturing	Supporting Innovation and Diversification in Manufacturing	Through the national Manufacturing Advisory Service, target support to firms that are ready and willing to innovate and assist their investment in diversifying their products, processes or markets
	Overcoming barriers to SME growth	Providing High Quality Business Support	Develop an integrated regional business support network
		Improving Access to Finance	Create a regional 'escalator' of funding sources, from both the public and private sectors, so that businesses have access to appropriate finance as they grow
	Supporting firms to become internationally competitive and attracting inward investment	Increasing International Trade	Support businesses to increase their overseas trade by providing tailored export services, including specialist support for businesses looking for opportunities in Brazil, Russia, India and China
		Targeting Foreign Direct Investment	Target FDI activity on those market sectors that are likely to contain knowledge driven, R&D intensive investments
	Building the visitor economy	Increasing Visitor Spend	Target regional and sub-regional marketing and promotion with the aim of increasing visitor spend, particularly from staying and inbound visitors, and develop a coordinated campaign to encourage investment in public realm, conferencing and business tourism
	Harnessing culture in the East Midlands	Targeting Growth of Creative and Cultural Industries	Protect, conserve and enhance the key regional cultural and historic assets to maximise their contribution to the regional economy

Aim	Priority	Priority Action	Description of Priority Action
	Supporting SMEs to harness business opportunities such as public procurement	Maximising the Benefits of Public Procurement	Develop a Regional Procurement Opportunities Plan to open up more market opportunities, in the region and nationally, to regional businesses
		Maximising the Benefits of the London 2012 Olympic and Paralympic Games	Develop a 2012 Action Plan
Innovation	Increasing investment in research and development	Increasing Research & Development	Provide targeted support to foster innovation within businesses and encourage them to undertake more research and development
		Developing Research Excellence	Develop research excellence so the region can compete for and benefit from a larger share of public and privately funded R&D
	Helping existing businesses deploy technologies and processes	Developing and Applying New Technologies	Provide assistance in the development, promotion and implementation of new enabling technologies, products and processes
	Resource efficiency through effective use of technology and management practices	Providing Business Support on Resource Efficiency	Introduce a range of resource efficiency business support measures that enable regional businesses to adopt leading best practice
	Translating scientific excellence into business success	Maximising the Impact of Science City Nottingham	Maximise the impact of Nottingham's Science City designation to the benefit of the wider region particularly in science and technology focused infrastructure development and regeneration
		Commercialising Scientific Excellence through Facilitated Business Collaboration	Introduce more effective initiatives to facilitate greater collaboration between businesses and the regional research community, including the universities
		Development of Land and Property	Develop land, property and facilities which maximise opportunities for collaborative innovation activities and inward investment by providing quality sites and buildings which support enterprise development
	Growing the regions key sectors	Growing the Region's Key Sectors	Ensure that the priority sectors (transport equipment, construction, food and drink and healthcare) are considered in the implementation of other actions in the RES to support growth, address skills needs and focus on efficiency
Transport and Logistics	Infrastructure, accessibility and connectivity	Improve Transport Connectivity and Accessibility	Improve inter and intra-regional connectivity by strengthening links between the region's main urban centres, improving reliability on key routes for passengers and freight, and address poor connectivity or capacity to key centres in other regions, including London, Leeds, Birmingham, and Manchester; improve international accessibility by improving surface access to NEMA and other airports serving the region; implement demand management measures, and improve access to recreation, sport, and cultural facilities

Aim	Priority	Priority Action	Description of Priority Action
		Maximise Benefits of NEMA and Robin Hood Airport	Surface access improvements to reduce the local impact of transport movements; secure employment land supply in local urban areas; ongoing mitigation and technological responses to help reduce local noise and wider environmental impacts of the forecast growth in freight and passenger activity
		Travel Demand Management	Improving transport efficiency and reducing road congestion by developing innovative approaches to behavioural change, travel demand management, and integration, including exploring measures of congestion charging
Energy and Resources	Responding to the challenge of climate change	Adaptation to Climate Change	Ensure that public and private sector leaders understand and respond to the impacts of climate change by: developing a regional climate change adaptation and mitigation strategy/action plan; and providing support to businesses to undertake climate change
		Reducing the Demand for Energy and Resources	Ensure that energy and resource use is minimised by: investing in better management and skills; driving change through public procurement; encouraging use of low carbon technologies; and stimulating clean design
	Exploitation of new and growing low carbon markets	Utilising Renewable Energy Technologies	Maximise the economic and environmental benefits of renewable energy technologies by promoting their development and deployment
		Exploiting Low Carbon Technologies	Ensure that businesses are well placed to exploit the opportunities presented by the growing global marketplace for low carbon products and services
	Ensuring infrastructure for low carbon economy	Energy and Waste Capacity	Promote the development of a more secure, diverse and sustainable energy and waste infrastructure and innovative approaches to providing energy and waste services by: promoting and investing in renewable and low carbon energy generation; promoting and inv
Environmental Protection	Protecting and enhancing our environmental infrastructure to ensure sustainable economic growth	Environmental Infrastructure	Develop and promote innovative and sustainable approaches to supply and demand management (relating to travel, energy, water and materials) to reduce pressures on environmental infrastructure
		Sustainable Construction	Ensure that investments in the built environment integrate climate change considerations
		Cleaner Production Processes	Support the development and adoption of cleaner production processes and shift consumption towards goods and services with lower environmental impacts
	Protecting and enhancing green infrastructure through environmental stewardship	Improve Damaged Environments	Improve natural environments, damaged as a legacy of former industrial and development activity, particularly where this is a barrier to investment in the region, especially in the coalfields; and encourage sustainable agriculture which enhances and protects the regions biodiversity
		Protect and Enhance Green Infrastructure	Encourage the integration of green infrastructure issues into the planning system, and work with developers and land owners to ensure that opportunities for new or improved green infrastructure are integrated into physical development schemes
Land and Development	Development land	Secure the Supply of Quality Employment Land	Ensuring and safeguarding an appropriate supply of quality employment land by providing supportive local and regional plans and policies
		Infrastructure for Employment Related Schemes	Ensure appropriate levels of infrastructure including transport, utilities and ICT for employment-related schemes

Aim	Priority	Priority Action	Description of Priority Action
		Previously Developed Land and Buildings	Increase the re-use of previously developed land through an appropriate mix of actions including site remediation, reclamation and redevelopment, and ensure that effective use is made of the existing stock of buildings
	Housing	Supporting Infrastructure for Housing Growth	Ensure provision of transport, economic, cultural, and community infrastructure, including green infrastructure
		Regeneration - Areas of Low Housing Demand	Ensure that regeneration and economic, social and environmental inclusion benefits are integral to future developments in areas of low housing demand through the provision of new and improved housing and community and economic infrastructure
		Range of Housing Provision	Improve the range, mix and quality of housing in the region, including the renewal of existing housing stock
Cohesive Communities	Cohesive Communities	Promoting Social Capital	Support initiatives which mobilise existing social capital and create bridges and links between different groups including volunteering opportunities
		Collaboration to Encourage Participation	Encourage collaboration between cultural, leisure and tourist bodies to encourage community participation, build social capital and contribute to community cohesion
		Develop Cohesive Communities	Support the development of cohesive communities through Local Area Agreements
Economic Renewal	Building local capacity, resources and support	Effective Engagement and Involvement of Local Businesses and Residents	Ensure that people and businesses in local communities have the skills and capacity to develop local economic renewal solutions
		Inclusive Business Support	Ensure that business support is responsive to the needs of all communities and under-represented groups
	Reviving local infrastructure and environments	Built and Green Environments	Improve the quality of the built and green environments to enhance local economic prospects through applying best practice standards for design and construction and working with developers to ensure the integration of green infrastructure factors and improving the public realm in development briefs
		Addressing Crime	Reduce the impacts of crime on communities and businesses through neighbourhood and business crime reduction initiatives and activities to reduce re-offending
	Stimulating new markets and enterprise opportunities	New Markets and Enterprise Opportunities	Stimulate new local markets and enterprise opportunities by unlocking the potential of local procurement by: encouraging local public authorities to adopt procurement approaches which deliver local, social, environmental and community benefits; encouraging large businesses to consider supply chain opportunities in their local areas
		Improve Access to Finance	Improve access to finance for all entrepreneurs irrespective of location, personal characteristics and type of business

Aim	Priority	Priority Action	Description of Priority Action
Economic Inclusion	Employability	Enhance Employability of the Most Disadvantaged	Improve the employability of those without skills and qualifications
		Address Worklessness	Address persistent and high levels of worklessness in communities by connecting local people to job opportunities created by public sector investment in key infrastructure projects, and by encouraging private sector developers and employers to recruit from under utilised local labour sources
		Improving Diversity of the Workforce	Work with employers to increase the diversity of the East Midlands workforce
	Achieving a healthy workforce	Working With Employers to Improve the Health of the Region's Workforce	Ensure that employers are informed on the detrimental effects of poor health on business performance and take steps to improve and protect the health of their employees
		Address Ill Health as a Barrier to Employability	Ensure that those who experience poor health as a barrier to employment are supported in entering the labour market in positions consistent with their personal circumstances

Table 10.6 Priority Actions of the RES and Relationship with Other Regional Strategies

Aims	Strategic Priorities	Priority	Priority Action	Relevant SD Objectives	Water Strategy	Waste Strategy	Energy Strategy	Biodiversity Strategy	Health Strategy	Culture Strategy	Freight Strategy	International Trade	Tourism Strategy	Transport Strategy
RAISING PRODUCTIVITY	Employment, Learning and Skills	Developing the skill levels of the current and future workforce	Engage Schools and Colleges with Businesses	5, 11										
			Developing Adult Workforce Skills	5, 11										
		Stimulating business demand for skills	Stimulating Skills Demand	5, 11										
		Improving the infrastructure and responsiveness of skills supply	Matching Skills Provision to Employer Demand	5, 11										
		Exploiting the opportunity of Higher Education	Exploiting the Opportunity of Higher Education	5, 11										
	Enterprise and Business Support	Building an enterprise culture	**Harness a Culture of Enterprise**	5, 12										
		Creating a dynamic SME base	**Targeted Provision to Improve Business Creation**	5, 11, 12										
		Supporting innovation and diversification in manufacturing	Supporting Innovation and Diversification in Manufacturing	11, 12, 13										
		Overcoming barriers to SME growth	Providing High Quality Business Support	12,13										
			Improving Access to Finance	12, 13										
		Supporting firms to become internationally competitive and	Increasing International Trade	11, 12, 13										

Aims	Strategic Priorities	Priority	Priority Action	Relevant SD Objectives	Water Strategy	Waste Strategy	Energy Strategy	Biodiversity Strategy	Health Strategy	Culture Strategy	Freight Strategy	International Trade	Tourism Strategy	Transport Strategy
		attracting inward investment	Targeting Foreign Direct Investment	12, 13										
		Building the visitor economy	Increasing Visitor Spend	3, 11, 13										
		Harnessing culture in the East Midlands	Targeting Growth of Creative and Cultural Industries	3, 6, 7										
		Supporting SMEs to harness business opportunities such as public procurement	Maximising the Benefits of Public Procurement	11										
			Maximising the Benefits of the London 2012 Olympic and Paralympic Games	11										
	Innovation	Increasing investment in research and development	Increasing Research & Development	11, 12										
			Developing Research Excellence	11, 12										
		Helping existing businesses deploy technologies and processes	Developing and Applying New Technologies	11, 12										
		Resource efficiency through effective use of technology and management practices	Providing Business Support on Resource Efficiency	8, 9, 12, 13, 16										
		Translating scientific excellence into business success	Maximising the Impact of Science City Nottingham	13, 14										
			Commercialising Scientific Excellence through Facilitated Business Collaboration	11, 12										

Aims	Strategic Priorities	Priority	Priority Action	Relevant SD Objectives	Water Strategy	Waste Strategy	Energy Strategy	Biodiversity Strategy	Health Strategy	Culture Strategy	Freight Strategy	International Trade	Tourism Strategy	Transport Strategy
			Development of Land and Property	11, 12										
		Growing the regions key sectors	**Growing the Region's Key Sectors**	9, 12, 13, 14, 16										
ENSURING SUSTAINABILITY	Transport and Logistics	Infrastructure, accessibility and connectivity	**Improve Transport Connectivity and Accessibility**	3, 13, 14, 15, 17										
			Maximise Benefits of Nottingham East Midlands Airport and Robin Hood Airport	13, 15, 17										
			Travel Demand Management	10, 14, 17										
	Energy and Resources	Responding to the challenge of climate change	Adaptation to Climate Change	1, 2, 3, 6, 7, 8, 10, 13,15										
			Reducing the Demand for Energy and Resources	2, 6, 7, 8, 9, 10, 13, 15, 16, 17										
		Exploitation of new and growing low carbon markets	Utilising Renewable Energy Technologies	9, 12, 13										
			Exploiting Low Carbon Technologies	12, 13										

Aims	Strategic Priorities	Priority	Priority Action	Relevant SD Objectives	Water Strategy	Waste Strategy	Energy Strategy	Biodiversity Strategy	Health Strategy	Culture Strategy	Freight Strategy	International Trade	Tourism Strategy	Transport Strategy
		Ensuring an infrastructure for a low carbon economy	**Energy and Waste Capacity**	8, 9, 13, 15, 16										
	Environmental Protection	Protecting and enhancing our environmental infrastructure to ensure sustainable economic growth	Environmental Infrastructure	3, 6, 7, 8, 9, 15, 16										
			Sustainable Construction	15										
			Cleaner Production Processes	9, 13, 15, 16										
		Protecting and enhancing green infrastructure through environmental stewardship	Improve Damaged Environments	6, 7, 9, 14										
			Protect and Enhance Green Infrastructure	6, 7, 15										
	Land and Development	Development land	**Secure the Supply of Quality Employment Land**	6, 7, 13, 14, 15										
			Infrastructure for Employment Related Schemes	13, 17										
			Previously Developed Land and Buildings	6, 7, 14, 15										
		Housing	Supporting Infrastructure for Housing Growth	3, 7, 14, 15										

Aims	Strategic Priorities	Priority	Priority Action	Relevant SD Objectives	Water Strategy	Waste Strategy	Energy Strategy	Biodiversity Strategy	Health Strategy	Culture Strategy	Freight Strategy	International Trade	Tourism Strategy	Transport Strategy
			Regeneration in Areas of Low Housing Demand	1, 14, 15										
			Range of Housing Provision	1, 6, 7, 14, 15										
ACHIEVING EQUALITY	Cohesive Communities	Cohesive Communities	Promoting Social Capital	5										
			Collaboration to Encourage Participation	3, 5, 6										
			Develop Cohesive Communities	4										
	Economic Renewal	Building local capacity, resources and support	Effective Engagement and Involvement of Local Businesses and Residents	5, 11, 17										
			Inclusive Business Support	5, 11, 17										
		Reviving local infrastructure and environments	Built and Green Environments	2, 6, 7, 8, 10, 14, 15										
			Addressing Crime	2, 4										
		Stimulating new markets and enterprise opportunities	New Markets and Enterprise Opportunities	11, 17										
			Improve Access to Finance	11, 12										

Aims	Strategic Priorities	Priority	Priority Action	Relevant SD Objectives	Water Strategy	Waste Strategy	Energy Strategy	Biodiversity Strategy	Health Strategy	Culture Strategy	Freight Strategy	International Trade	Tourism Strategy	Transport Strategy
	Economic Inclusion	Employability	Enhance Employability of the Most Disadvantaged	5										
			Address Worklessness	5, 12, 17										
			Improving Diversity of the Workforce	12, 17										
		Achieving a healthy workforce	Working With Employers to Improve the Health of the Region's Workforce	2, 7, 10, 11										
			Address Ill Health as a Barrier to Employability	2, 11, 17										
		Enterprising people	Develop Entrepreneurship Skills	11, 12										